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(with updates in 2010)

CHAPTER 41.
TERRESTRIAL WILDLIFE AND HABITAT
Cook Inlet Drainages

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ACRONYMS AND ABBREVIATIONS

AD&FG	Alaska Department of Fish and Game
ADOT&PF	Alaska Department of Transportation and Public Facilities
AKNHP	Alaska Natural Heritage Program
asl	above sea level
ASG	Alaska Shorebird Group
AWC	Anadromous Waters Catalog
BBS	(North American) Breeding Bird Survey
BLM	Bureau of Land Management
BPIF	Boreal Partners in Flight
ESA	Endangered Species Act
GIS	geographic information system
GMU	Game Management Unit
GPS	global positioning system
HGM	hydrogeomorphic
km^2	square kilometer(s)
KNP	Katmai National Park
LCNP	Lake Clark National park
MCH	Mulchatna Caribou Herd
MLLW	mean lower low water
NOAA	National Oceanic and Atmospheric Association
NPS	National Park Service
USFWS	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
USGS	U.S. Geological Survey

41. WILDLIFE AND HABITAT—COOK INLET DRAINAGES

41.1 Habitat Mapping and Habitat-value Assessments

41.1.1 Introduction

This chapter section summarizes the wildlife habitat mapping and habitat-value assessment studies conducted for the Cook Inlet drainages study area. This work was conducted to provide a baseline inventory of the availability of terrestrial, freshwater, and marine wildlife habitats in the study area and an assessment of the value of the those habitats to a selected set of bird and mammal species of concern.

41.1.2 Study Objectives

The primary objectives of the wildlife habitat mapping and habitat-value assessment studies are to provide baseline mapping of wildlife habitats in the Cook Inlet drainages study area, quantify the areal coverage of the habitat types present, and identify the importance of those habitats to wildlife species.

41.1.3 Study Area

In 2004, the wildlife habitat mapping field surveys in the Cook Inlet drainages were conducted within a 400-meter-wide study corridor. In 2005, the field survey area was updated to a 610-meter-wide corridor (14 square kilometers in area). The field survey area in 2005 also encompassed the Y-shaped valley (Y Valley) to the north and northwest of Knoll Head. Currently, the Cook Inlet drainages study area designated for mapping wildlife habitats comprises 16 square kilometers within a 610-meter-wide corridor (Figure 41.1). For much of its length, the centerline of the corridor study area runs along the shorelines of Iliamna and Iniskin bays and includes both terrestrial/freshwater habitats onshore and marine habitats in the intertidal and nearshore environments of the bays.

The Cook Inlet drainages study area encompasses terrestrial, freshwater, and marine wildlife habitats (Figures 41.1-1, 41.1-2, and 41.1-3). The corridor study area runs from the western shoreline of Iniskin Bay north of Knoll Head, then west around North Head and up the eastern shore of Iliamna Bay; it crosses Iliamna Bay and then runs west along Williams Creek to the pass that separates the Cook Inlet drainages from the Bristol Bay drainages. The area is strongly influenced by the Cook Inlet coastal climate and includes alpine areas, steep coastal mountain slopes, two prominent creek valleys, a portion of upper Iliamna Bay, and marine habitats along the shorelines of Iliamna and Iniskin bays. The terrain in the area is generally mountainous with fast-flowing creeks, but a gently sloping area occurs in the Y Valley north of Knoll Head. Subalpine areas of white spruce (*Picea glauca*) woodland with upland dwarf scrub and graminoid-herb openings are common in the creek valleys. A few areas of poplar (*Populus balsamifera* and *Populus trichocarpa*) forests and mixed white spruce/poplar forests also occur in the creek valleys. Some more well-drained areas at higher elevations are dominated by upland dwarf scrub. Occasional small forest openings, dominated by wetter graminoid and scrub-bog vegetation, also occur. The area is best described, however, by the extensive tall-scrub vegetation which strongly dominates the terrestrial portions of the study area, occurring on upland slopes, in the lowlands, and in riverine areas.

These tall-scrub habitats are dominated by closed stands of Sitka alder (*Alnus sinuata*) and thinleaf alder (*A. tenuifolia*).

The marine portions of the Cook Inlet drainages study area include supratidal cliffs, estuarine saltmarsh, and both rocky and soft-sediment intertidal habitats. Mud flats, sand flats, gravel/sand beaches, rocky ramps and platforms, and rocky cliffs are common intertidal habitats along the coastline. Offshore of the intertidal habitats, the study area also includes a narrow stretch of nearshore subtidal waters. The marine habitats in the Cook Inlet drainages study area represent only a small portion of the supratidal, intertidal, nearshore, and offshore habitats within the larger Cook Inlet marine study area used for surveys of marine wildlife throughout the Iliamna and Iniskin bay area (see Chapter 44).

41.1.4 Previous Studies

Only coarse-scale land-cover mapping has been conducted in the region surrounding the Cook Inlet drainages study area. Early mapping of the area was conducted for the Bristol Bay Land Cover Mapping Project (Wibbenmeyer et al., 1982a; b). These data were derived from a classification of Landsat Mulitspectral Scanner satellite imagery. Subsequently, additional coarse-scale land-cover mapping for the State of Alaska was conducted using Advanced Very High Resolution Radiometer satellite data; the land cover classes in this case were developed using a vegetation phenology index from data collected during the 1991 growing season (USGS, 1998). Given the relatively low accuracy of spectral image classifications at fine-scales, and with cell sizes of 50 meters in Wibbenmeyer et al. (1982a) and one square kilometer in USGS (1998), neither of these mapping products will provide the necessary accuracy or resolution to characterize wildlife habitats at a local scale within the Cook Inlet drainages study area. Both of these datasets, however, may be useful in characterizing wildlife habitats on a coarser regional scale.

More recently, a spectral image classification for Lake Clark National Park was conducted using Spot multispectral imagery acquired in 1995; this mapping was augmented with field data, aerial photo interpretation, and other geographic information system (GIS) datasets and is reported to be 83 percent accurate (NPS, 2001). Unfortunately, the mapping resolution is still fairly coarse (cell size of 30 meters) and the data do not cover the Cook Inlet drainages study area. These data still may be useful, however, in helping to characterize wildlife habitats at a coarser regional scale (e.g., for calibrating other coarse-scale mapping datasets such as Wibbenmeyer et al. [1982a] and USGS [1998] that do encompass the Cook Inlet drainages study area).

41.1.5 Scope of Work

The wildlife habitat mapping study was conducted by Charles T. Schick, Wendy A. Davis, Matthew J. Macander, and Joanna E. Roth, of ABR, Inc. (hereafter ABR). Field surveys to ground-truth the aerial photography for the habitat mapping study were conducted during August 2004 and 2005. The field studies were conducted by Sally E. Anderson, Gerald V. Frost, Chandra B. Heaton, Patricia F. Miller, Erik R. Pullman, Joanna E. Roth, and Charles T. Schick according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and the *Draft Environmental Baseline Studies, 2005 Study Plans* (NDM, 2005). The mapping of marine habitats was added to the scope of work in 2010. Digital habitat mapping was conducted by Wendy A. Davis, Patricia F. Miller, Katherine L. Beattie, Matthew J. Macander, and Charles T. Schick. The wildlife habitat-value assessments were conducted by Brian E. Lawhead and Alexander K. Prichard (mammals), Robert J. Ritchie (raptors), Ann M. Wildman (waterbirds), and Charles T. Schick (landbirds and shorebirds).

The habitat mapping and habitat-value assessment studies included the following tasks:

- Conduct field surveys to ground-truth the aerial photography and determine the photosignatures for vegetation, physiography, and surface forms in the Cook Inlet drainages study area.
- In a GIS, add physiographic categories (and landform and surface-form categories, as needed) to the vegetation map polygons prepared by HDR Alaska, Inc. (HDR).
- Combine vegetation and physiographic information (and landform and surface-form information, as needed) to develop preliminary multivariate wildlife habitat types.
- Aggregate the preliminary habitat types to develop a final set of terrestrial and freshwater habitat types suitable for evaluations of use by terrestrial birds and mammals in the study area.
- Utilize existing marine shoreline mapping data for the study area to derive a set of marine habitat types suitable for evaluations of use by marine birds and mammals in the study area.
- Conduct habitat-value assessments for the mapped habitat types using terrestrial and marine wildlife survey data specific to the Cook Inlet drainages study area and habitat-use information from the scientific literature.

41.1.6 Methods

41.1.6.1 Habitat-mapping Field Surveys and Data Management

Field surveys to ground-truth the aerial photography for the Cook Inlet drainages study area were conducted on August 24 and 25, 2004 and from August 9 through 12, 2005. Field plot locations were selected prior to the field work using either color-infrared or true-color aerial photography depending on the survey year. In 2004, researchers used high-altitude, color-infrared aerial photography from the National Aeronautics and Space Administration to determine ground-truth plot locations; this photography dates from the late 1970s and early 1980s and was reproduced in digital orthophoto format with 0.76-meter pixels by Aero-Metric, Inc. In 2005, sample plots were selected using true-color aerial photography acquired in early October 2004 for the Cook Inlet drainages study area (digital orthophotos with 0.46-meter pixels produced by Aero-Metric, Inc.).

Field sample plots were located along transects that crossed a number of distinct vegetation types or photosignatures identifiable on the aerial photography. Transects were located in areas that maximized the range of possible vegetation types to be encountered over distances that could be easily walked in a day. Field plots were accessed by helicopter, with a drop-off in the morning and a pick-up in the evening, and then on foot using handheld global positioning system (GPS) receivers and field maps of the digital aerial photography for the study area. Once at a particular field plot location, the final point to sample was chosen to reside in the habitat area representative of the larger type that would eventually be delineated as a map polygon from the aerial photography (i.e., small inclusions of other habitat types were avoided). Twenty-seven habitat-mapping field plots were sampled in 2004 and 59 plots in 2005. Considering both years combined, 86 field plots were sampled in the Cook Inlet drainages study area.

At each ground-truth plot, vegetation data were collected by assessing plant species composition and vegetation structure visually using percent-cover estimates within a 10-meter radius of the plot center. Cover estimates of individual plant species were made to the nearest 5 percent for cover values greater than or equal to 10 percent and to the nearest 1 percent for cover values less than 10 percent. Vegetation structure was documented by estimating the percent cover of all species combined in vegetation structure/strata classes (e.g., needleleaf trees, deciduous trees, tall shrubs, low shrubs, dwarf shrubs, forbs, graminoids, mosses, lichens) and in ground cover classes (water, litter, bare soil, rock). These data were used primarily to determine the most appropriate vegetation type for each field plot. The Level IV vegetation categories from *The Alaska Vegetation Classification* (Viereck et al., 1992) were used to classify the vegetation types in the Cook Inlet drainages study area.

In addition to vegetation data, physiographic and surface-form classes were recorded for each field plot from a list of pre-defined classes used by ABR for habitat mapping projects throughout Alaska. The physiographic types recorded at field plots in the Cook Inlet drainages study area were alpine, subalpine, upland, lowland, lacustrine, riverine, and coastal. Upland and subalpine areas were very similar and were combined into an upland physiographic class for the final habitat map (see Section 41.1.6.2 below). The surface-form categories included both microtopographic types (from Washburn, 1973) and macrotopographic types (from Schoeneberger et. al., 2002) in a system described in Jorgenson et al. (2002). To collect basic, descriptive information on soils (which often is helpful in separating physiographic types such as lowlands and riverine-influenced areas), a small 40-centimeter soil pit was dug to determine water depth, drainage, soil moisture, organic depth, and dominant mineral type (e.g., organic, sandy, loamy). Each soil pit was photographed, and documentary habitat photos and GPS coordinates were recorded at each field plot.

In the field, plant identifications for most vascular plants were made using *Flora of Alaska and Neighboring Territories* (Hultén 1968). Trees and shrubs, with the exception of willows (*Salix* spp.), were keyed using *Alaska Trees and Shrubs* (Viereck and Little, 1972). Willows were keyed using *A Guide to the identification of Willows in Alaska, the Yukon Territory and Adjacent Regions* (Argus 2001). The final taxonomic nomenclature for the field data follows Argus (2001) for willows and Viereck and Little (2007) for other trees and shrubs. Nomenclature for all other taxa follows *Flora of North America North of Mexico* (FNAEC, 1993–2009) except for those taxa in plant families not yet revised by the FNAEC, for which nomenclature from *The Plants Database* (USDA-NRCS, 2009) was used.

In 2004, all data were recorded on paper and entered into Microsoft Excel after the field surveys. In 2005, all data were recorded directly into Microsoft Excel in the field on pocket PCs. From Excel, the data from both years were uploaded to a Microsoft Access database designed specifically for the Pebble Project habitat mapping study. The field data then were checked for missing entries or errors in coding by using queries to compare the raw data with reference tables that list the plots surveyed and the correct codes for the data categories used. Quantitative vegetation data were checked for accuracy by comparing plot photos and field notes to the plant cover and vegetation-structure cover data for each plot. All data errors were corrected before proceeding with further study.

41.1.6.2 Mapping and Classification of Terrestrial/Freshwater Habitat Types

Vegetation Mapping

The first step in mapping terrestrial and freshwater wildlife habitats in the Cook Inlet drainages study area was the mapping of vegetation for the area (prepared by HDR). Vegetation mapping was completed for the eastern portion of HDR map section 16 (the western portion of map section 16 is in the transportation-corridor, Bristol Bay drainages study area) and for the full extent of HDR map section 17. The five map tiles displayed on Figure 41.1-3 were created to display the completed wildlife habitat mapping at a scale at which map polygons are discernable and do not represent the vegetation map sections used during the mapping process.

Habitat Map Development

To derive wildlife habitats, ABR added physiographic attributes (alpine, upland, lowland, lacustrine, riverine, and coastal) to the vegetation map polygons produced by HDR. After completion of the terrestrial/freshwater habitat mapping, the habitat map polygons identified in the coastal class were extracted and reworked to represent marine habitats (see Section 41.1.6.3 below). In general, except for water habitats (see below), the process of assigning physiographic attributes relied on aerial photo-interpretation of landforms (geomorphology) and surface-form types, and ultimately physiographic types. The ground-truth data collected during the field surveys described above were used to help facilitate the photo-interpretation of physiographic types. All aerial photo-interpretation and digitizing of physiographic features was performed onscreen using *ArcGIS 9.3* software. True-color aerial photography for the Cook Inlet drainages study area collected in October 2004 and September 2008 (digital orthophotos with 0.46-meter pixels produced by Aero-Metric, Inc.) was used as the basemap for this work. The older color-infrared aerial photography (described above) was referred to occasionally, especially to help discern scrub and graminoid habitats.

In assigning physiographic attributes, the initial vegetation polygons received from HDR first were split into water habitats and non-water habitats. Polygons with vegetation codes of Open Water (OW) or Aquatic Herbaceous (AH) were treated as water habitats while all other vegetation codes were assigned to the non-water habitat category. The water and non-water habitats were processed independently and then combined to produce a complete set of map polygons for the study area (see below).

Water Habitats

For water habitats, physiography was assigned based on the value of the hydrogeomorphic (HGM) field prepared by HDR. If the HGM field was Riverine or Riverine Corridor, the physiography was assigned to Riverine and the Rivers and Streams habitat type was used; otherwise, physiography was assigned to Lacustrine and the Lakes and Ponds habitat type was used.

To delineate those streams supporting anadromous fish, GIS shapefiles from the most current *Anadromous Waters Catalog* (AWC) (ADF&G, 2010) were obtained for southwestern and southcentral Alaska. These files were overlaid on the Rivers and Streams habitat type to visually identify which streams were anadromous. The scale of the AWC data was coarser than the detailed stream mapping in the study area, but generally it was clear to which channels the AWC data corresponded. The main channels of the rivers and streams that corresponded to the AWC data were manually assigned to the Rivers and Streams (Anadromous) habitat type.

Non-water Habitats

For non-water habitats, physiography was assigned based on aerial photo-interpretation, as described above under Habitat Map Development. ABR biologists assigned preliminary physiographic types manually to each non-water vegetation polygon prepared by HDR.

Once physiographic types were assigned to each map polygon in the two map sections, a preliminary set of wildlife habitat types for the Cook Inlet drainages study area was created by assembling all unique combinations of physiographic and vegetation type. This process resulted in a large number of habitat types with all possible combinations of physiographic and vegetation type included. A preliminary habitat type name was assigned to each physiography/vegetation combination when the interpretation was obvious. Other combinations in which the interpretation of a habitat type was unclear were noted as possible errors or as requiring further investigation to verify the classification of physiography.

The preliminary habitat map then was systematically reviewed at a scale of 1:2,000 except in cases where the existing mapping required closer analysis. Based on this review, the preliminary physiography type, which was mapped at a coarse scale, frequently was revised to conform to the finer-scale vegetation mapping. Two types of polygon editing also were performed. For cases in which a vegetation map polygon occurred in one or more physiographic types, the vegetation polygon was split to represent the different physiographic areas; the vegetation attributes in the resulting polygons remained the same. This alteration of polygon boundaries occurred most commonly during the process of delineating riverine areas for the vegetation types mapped by HDR. Second, river or stream channels occasionally were split from surrounding polygons and were recoded to the Open Water vegetation code. Other than this, no vegetation codes were changed.

The vegetation mapping included many very small polygons that in the ABR habitat-mapping approach would typically be treated as patches or inclusions of other types within a broader scale habitat type (these small polygons, when they are not waterbodies, are typically below the size to attract use by most vertebrate species). To facilitate the development of broader scale wildlife habitats and to reduce the number of very small polygons requiring physiography assignment and habitat review, a minimum polygon mapping size of 0.25 acre was enforced for non-water polygons (see below). Water bodies less than 0.25 acre were retained because these often represent an important habitat feature.

Non-water polygons less than 0.25 acre were merged into adjacent types through an automated procedure. First, the two map sections were merged into one seamless polygon file. The merged vegetation polygons at the original map-section boundary then were dissolved based on the preliminary habitat type, so that adjacent polygons with the same code were treated as a single habitat polygon. Dissolved non-water polygons less than 0.25 acre then were merged into the adjacent non-water polygon with the greatest shared border using the *ArcGIS 9.3 Eliminate* tool. This automated approach removed nearly all the very small non-water habitat patches. Islands in waterbodies that were less than 0.25 acre were retained because non-water polygons were not merged into adjacent water.

Habitat Aggregation

Following the review and refinement of physiography and preliminary habitat-type coding, and the elimination of very small non-water habitats, the preliminary habitat types were aggregated to produce a smaller set of final habitat types that better represent use by wildlife. This aggregation process was conducted to emphasize features in the final habitat types that are known to be important for use by wildlife in southwestern Alaska. As in other habitat mapping studies by ABR, the habitat aggregation process focused primarily on two variables (vegetation structure and physiography) and, to a lesser extent, on additional variables (landforms, surface-form features, proximity to open water, and elevation) as needed.

41.1.6.3 Mapping and Classification of Marine Habitat Types

To prepare for the mapping of marine habitats, researchers extracted the coastal habitat map polygons identified during the terrestrial/freshwater mapping (above) and then defined the marine shoreline as a line feature, which followed the boundary between the coastal and terrestrial/freshwater habitat polygons. The coastal map polygons and the marine shoreline then were split and coded, as described below, to represent marine habitats.

To classify marine habitats, researchers first divided the marine portion of the Cook Inlet drainages study area into three broad classes based on water depth at mean lower low water (MLLW): intertidal/supratidal, shallow subtidal water, and deep subtidal water. The two subtidal water classes were mapped using digital marine bathymetry data obtained from National Oceanic and Atmospheric Association Electronic Navigation Charts (NOAA, 2010a). In the NOAA Electronic Navigation Charts, the Depth_Area field represents bathymetry and each Depth_Area map polygon is coded with an upper depth and lower depth, referenced to MLLW. Within the mapping corridor, eight bathymetry polygons with depths between 0 and 1.8 meters occurred; these were aggregated and treated as one habitat type (Shallow Subtidal Waters). Fifteen bathymetry polygons with upper depths ranging from 1.8 to 18.2 meters and lower depths from 3.6 to 36.5 meters were aggregated and treated as a separate habitat (Deep Subtidal Waters). The remaining marine portions of the study area, which are exposed at MLLW, are in intertidal and supratidal zones.

The habitat types occurring in the supratidal and intertidal portions of the study area were classified using shoreline mapping data available online from the NOAA Alaska ShoreZone Coastal Mapping program. The best description of this coastal mapping information comes from the ShoreZone website directly (NOAA, 2010b):

> "ShoreZone is a coastal habitat mapping and classification system in which georeferenced aerial imagery is collected specifically for the interpretation and integration of geomorphic and biological features of the intertidal zone and nearshore environment. Oblique low-altitude aerial video and digital still imagery of the coastal zone is collected during the lowest tides of the year, usually from a helicopter flying at or below 100 m altitude. During image collection, the aircraft's GPS position is continuously recorded so that the video and still imagery have positional information. Video imagery is accompanied by continuous, simultaneous commentary by a geologist and a biologist aboard the aircraft. The imagery and commentary are used in the definition of discrete along-shore coastal habitat units and the mapping of observed physical, geomorphic, sedimentary, and biological across-shore components within

> those units. Units are digitized as shoreline segments in ArcGIS, then integrated with the along-shore and across-shore geological and biological data attribute tables housed in the geodatabase. Mapped habitat features include degree of wave exposure, substrate type, sediment texture, intertidal biota, and some nearshore subtidal biota”.

Eighty-one different shoreline segments occurred within the ShoreZone map data that apply to the Cook Inlet drainages study area. The shoreline segments in the ShoreZone data, however, were much more generalized than the detailed shoreline defined by the coastal-most extent of the terrestrial and freshwater habitat map polygons delineated in this study. To correct for this, the endpoints of each of the ShoreZone shoreline segments were moved manually to coincide with the nearest point (vertex) on the detailed coastline mapping. The detailed coastline then was split into the corresponding ShoreZone shoreline segments and the ShoreZone attributes were transferred. These data were adequate for the mapping of most of the intertidal/supratidal habitats in the study area (see below). The upper portions of the supratidal region (cliffs, bluffs), however, were not adequately represented in these shoreline segments. To map these features, the geomorphic form of the uppermost supratidal zone was extracted from the ShoreZone Across-Shore table for each shoreline segment. This information on the occurrence of cliffs and bluffs above the intertidal zone was used to define the Supratidal Cliff habitat; this habitat was mapped as a line feature.

The original coastal map polygons that were placed in the intertidal/supratidal class were coded to marine habitats by first determining which shoreline segment was closest to each polygon, based on Euclidean distance. Two ShoreZone attributes (Biological Exposure and BC [Coastal] Class) from each shoreline segment then were assigned to each matching intertidal/supratidal polygon. From the resulting set of each unique combination of Biological Exposure and BC Class, a smaller set of final intertidal/supratidal habitats was developed by combining polygons that shared similar Biological Exposure and BC Class features and that would be used similarly by wildlife. In particular, the three Biological Exposure classes in the study area were aggregated into two: the protected and semi-protected classes were combined into one class (protected), and the semi-exposed class was treated as exposed for simplicity. For the BC Class variables, rocky ramps (inclined 5 to 20 degrees) and rocky platforms (inclined less than 5 degrees) were combined into one class (rocky ramp–platform). Similarly, sand/gravel flats or fans (of limited extent in the study area) and sand/gravel beaches were combined into one class (sand/gravel beach) because the two types were expected to be used similarly by wildlife.

Finally, some manual corrections to the marine habitat map classes had to be made for accuracy. First, the boundaries of the Protected Estuary habitat were revised based on photo-interpretation to reflect that actual area of vegetated and partially vegetated estuarine habitats in the study area (non-vegetated estuarine habitats in the ShoreZone mapping program are treated either as mud flats or sand flats). Second, the total width of the intertidal and supratidal zone based on the ShoreZone Across-Shore data was calculated for each shoreline segment and was compared visually to the mapped extent of the polygons in the intertidal/supratidal class. In several cases, the mapped intertidal/supratidal zone appeared to be too wide when compared to the ShoreZone Across-Shore data. In these cases, the areal extent of the intertidal/supratidal zone was reduced and the area of Shallow Subtidal Waters was increased, based upon inspection of the total width of the intertidal/supratidal zone as indicated in the ShoreZone Across-Shore data and interpretation of the low-tide line on IKONOS satellite imagery acquired near low tide on July 9, 2004.

In general, the boundaries between adjacent terrestrial and freshwater habitat types can be mapped more precisely than the boundaries between adjacent marine habitats. The mapping of marine habitats, as conducted in this study, was based on information collected at or near low tide, but the extent of many of the intertidal habitats and the quality (depth) of the subtidal habitats important to wildlife can change dramatically depending on the tide level. Therefore, the marine habitat mapping reported here is an approximate representation of the distribution of marine habitats in the study area, but does not depict fixed boundaries.

41.1.6.4 Habitat-value Assessments

A subset of 61 species was assessed for wildlife habitat values from the full set of bird and mammal species known or expected to occur in the Cook Inlet drainages study area (Table 41.1-1). Habitat values for 39 of the 61 species that occur in terrestrial and/or freshwater habitats were assessed for the terrestrial and freshwater habitats that were mapped in the study area, and habitat values for 43 of the 61 species known to use marine habitats were assessed for the marine habitats mapped. The habitat-value assessments for both the terrestrial/freshwater mapping and the marine habitat mapping apply only to the habitats within the mapped areas. This is important to keep in mind, especially for the marine habitats, because only a limited mapping of marine habitats was conducted in the portions of the corridor study area that extend into marine areas. From this mapping, a full analysis of habitat use by marine wildlife in intertidal areas, and in nearshore and offshore waters in the Iliamna/Iniskin bay area cannot be made.

For birds, which are more easily detected than mammals, ABR researchers have a verified list of the species that occur in the Cook Inlet drainages study area. For mammals, and especially for the smaller terrestrial species (furbearers and small mammals), the occurrence information for the Cook Inlet drainages study area is less complete, hence researchers constructed a list of those mammal species observed and those with a reasonable likelihood of occurring in the study area. The species to be assessed for habitat values then were selected for their conservation, cultural, and/or ecological importance using the criteria listed below. To be included in the subset of species for habitat-value assessments, each species had to fall into at least one of the five categories below.

- Legally protected species under the Endangered Species Act (ESA) or the Bald and Golden Eagle Protection Act.
- Species of conservation concern for southwestern Alaska (based on the most current listings of species of conservation concern for the Cook Inlet drainages study area; see Chapter 45).
- Species is sensitive to human disturbance and development in freshwater habitats and serves as an indicator of environmental health.
- Species of concern for management, primarily because of subsistence and/or sport hunting/trapping use.
- Species provides important ecological function(s) because of its role as predator or prey (not otherwise represented by another species under one of the other criteria above), or because its presence can result in broader ecosystem effects (e.g., beaver).

Wildlife habitat-value assessments then were conducted using the habitat mapping described above and the wildlife survey data collected by ABR for the Pebble Project. The wildlife survey data were augmented, for those species with few observations, with assessments of habitat use from the scientific literature and/or from professional judgment based on extensive field experience with bird and mammal species in Alaska. This process generally involved four steps: (1) overlaying the wildlife observations on the habitat-map polygons in a GIS to determine the specific habitats being used at the time of observation; (2) assessing the frequency of use of each habitat type from the survey data; (3) evaluating coverage of the survey data to determine which habitats and wildlife species may be adequately sampled, undersampled, or unsampled; and (4) augmenting the project-specific observations (for undersampled and unsampled species and habitats) with information on habitat use derived from the scientific literature and/or from professional judgment. More specific methods for the habitat-value assessments are listed below in the separate subsections for each wildlife species group.

For each of the 61 bird and mammal species assessed, habitat values for each mapped habitat type were categorized into one of four value classes: high, moderate, low, or negligible value (Table 41.1-2). For birds, the assessment of habitat value in the Cook Inlet drainages study area was based primarily on the observed or potential use of the available habitats for breeding (nesting and brood-rearing), and for foraging during the breeding, migration, and wintering seasons (if applicable). For terrestrial mammals, the assessment of habitat value in the Cook Inlet drainages study area was based on several criteria: (1) the availability of specific plant foods (for herbivores and omnivores) or the expected availability of specific prey (for carnivores); (2) the presence of habitat suitable for denning/overwintering; and (3) the presence of suitable vegetation cover for concealment. For marine mammals, habitat values were assessed based on the observed use of mapped habitats in the study area during surveys for marine wildlife (see Chapter 44) relative to the occurrence of the species in the broader Iliamna/Iniskin bay area.

Mammals

Sixteen mammal species of concern were assessed for habitat values in the Cook Inlet drainages study area (13 terrestrial mammals and 3 marine mammals; Table 41.1-1). Another marine mammal listed as endangered under the ESA, Steller sea lion (*Eumetopias jubatus*) occurs seasonally (spring through fall) in small numbers on islands at the mouth of Iniskin Bay and further offshore in the open bight between Iliamna and Iniskin bays (see Chapter 44). Steller sea lions, however, were not assessed for marine habitat values in this study because they have been found only in offshore waters and around the Iniskin Islands, and these habitats do not occur in the Cook Inlet drainages study area.

For mammals, habitats rankings were based primarily on findings from a review of pertinent literature on habitat preferences and requirements for each species. The literature review was augmented by personal observations of the various species during field work conducted in the region of the Pebble Project since 2004. Because the literature for mammals seldom had information related to the specific habitat types mapped in the Cook Inlet drainages study area, researchers assessed habitat value based on general characteristics such as vegetation structure (e.g., forest, grassland, shrubs), elevation (e.g., lowland, upland, or alpine), occurrence of riverine areas, or presence of specific plant species known to be important for forage. Habitats were given low rankings if the species was thought to be absent or rare in a particular area. For instance, few terrestrial mammal species, other than brown bears, are expected to occur in marine habitats in the Cook Inlet drainages study area.

To assist with habitat rankings, researchers compiled a list of all mammals observed in mapped habitats during wildlife surveys for the Pebble Project. The sources of data included ABR aerial-transect surveys for terrestrial wildlife (see Section 41.2); locations of terrestrial mammals recorded opportunistically during aerial and ground-based surveys for bird species; and ABR aerial and boat-based surveys of marine wildlife in the bays of the Cook Inlet marine study area (see Chapter 44) . For three reasons, however, mammal observational location data were not subject to statistical analysis of habitat use. First, many of the locations were too imprecise to map habitats accurately. Telemetry data in particular can be offset from the true location by over 1 kilometer. Second, most observation methods (and opportunistic sightings in particular) are biased by the differing detectability of animals in different habitats. Animals are more likely to be observed in open habitats than closed habitats because they are easier to spot. Third, the search areas differed for each type of location data, meaning that the proportional coverage of each mapped habitat differed, and this difference would have to be accounted for in any comparison of habitat use and availability. Data screening to isolate only the data with high spatial resolution, high detectability, and a known search area resulted in sample sizes too small for statistical analysis.

Raptors

The assessment of habitat value for nesting and foraging raptors was based on project-specific habitat-use information for raptor nests and raptor observations recorded in or near the Cook Inlet drainages study area (see Section 41.3), personal field observations in the region of the Pebble Project, habitat descriptions in the scientific literature for raptor populations in Alaska and elsewhere in their ranges, and personal field experience of the raptor biologists involved in this project. Habitat values for seven species of concern (Bald and Golden eagles, Northern Goshawks, Peregrine Falcons, Gyrfalcons, Merlins, and Great Horned Owls) were assessed by combining nesting, foraging, and migration habitat values to derive an overall habitat value for each wildlife habitat mapped in the study area. These seven raptor species were selected because of their protected status, their status as species of conservation concern (see Chapter 45), and/or their ecological importance as predators of other wildlife species.

Waterbirds

The three waterbird species that were recorded or expected to occur in terrestrial and/or freshwater habitats in the Cook Inlet drainages study area during the breeding or migration seasons and were assessed for habitat value were Trumpeter Swan, Harlequin Duck, and Arctic Tern (Table 41.1-1). Trumpeter Swan is a sensitive species and an indicator of the environmental health of lakes and wetlands, and Harlequin Duck is an indicator of productive riparian areas; both of these species are sensitive to contaminants, changes in water quality, human disturbance, and they return to the same nesting territory year after year, often reusing nest sites (Bengtson, 1966; Robertson and Goudie, 1999; Mitchell and Elchholz, 2010). Arctic Tern is considered a species of conservation concern for southwestern Alaska (see Chapter 45). Habitat values for these species were assessed using a combination of (1) project-specific survey data (pre-nesting, nesting, and brood locations from breeding-season surveys and migrant flock locations from migration surveys, see Section 41.4); (2) habitat-use information from the scientific literature; and (3) knowledge of habitat use during breeding and migration in other areas of Alaska.

Habitat values were assessed for 15 species of waterbird species of concern that occur or are likely to occur in marine habitats in the Cook Inlet drainages study area (Table 41.1-1). One species, Steller’s Eider, was selected because it is federally protected as a threatened species under the Endangered Species Act. Eight species were selected based on their status as species of conservation concern (see Chapter 45) and include, Surf Scoter, Black Scoter, Long-tailed Duck, Red-throated Loon, Horned Grebe, Red-faced Cormorant, Pelagic Cormorant, and Marbled Murrelet. An additional five species (American Wigeon, Mallard, Northern Pintail, Green Winged-Teal, and Greater Scaup) were chosen because they are of management concern for subsistence or for sport hunting. Lastly, Harlequin Ducks are a species sensitive to environmental change (Robertson and Goudie, 1999), and they spend the non-breeding season in the marine environment of the Cook Inlet drainages study area and the breeding season in the streams along the Cook Inlet coast (see Section 41.4 and Chapter 44). Because American Wigeon, Mallard, Northern Pintail, and Green Winged-Teal all use similar habitats in the marine environment, they are discussed collectively as dabbling ducks. Greater Scaup, Surf Scoter, Black Scoter, and Long-tailed Duck stage in large numbers in the Cook Inlet drainages study area during the non-breeding season and are discussed collectively as diving ducks.

Survey data from three different sources were used for developing habitat rankings for waterbirds for each of the marine habitats mapped in the Cook Inlet drainages study area. Waterbird location data collected during boat-based and helicopter-based surveys in the Cook Inlet marine study area (see Chapter 44) was overlaid on the habitat-map polygons to determine the specific habitats being used at the time of observation. Boat-based surveys were conducted in nearshore and offshore waters during early summer, mid-winter, and early and late spring in 2004 to 2006. Helicopter-based surveys were flown during most months of the year, with the exception of summer, from February 2006 to April 2008. In addition, general area location data were recorded during fixed-winged surveys of all waterbirds during spring and fall migration periods in 2004 and 2005. The scientific literature was used to obtain additional information on the preferred habitats and behavior of foraging waterbirds in marine habitats.

Shorebirds and Landbirds

Habitat values were assessed for a set of 21 breeding shorebird and landbird species of concern (12 shorebirds and 9 landbirds; Table 41.1-1) that were recorded or are expected to occur in the Cook Inlet drainages study area. These species were selected based on their status as species of conservation concern (see Chapter 45) or because of management concern for sport and subsistence hunting (grouse and ptarmigan only). Species expected to occur were assessed because the point-count survey coverage of the Cook Inlet drainages study area was less extensive than in the mine study area and the transportation-corridor, Bristol Bay drainages study area, and many habitats in which uncommon species could occur were undersampled or unsampled (see Section 41.5). For each shorebird and landbird species addressed, researchers categorized habitat values for each of the wildlife habitat types mapped in the study area into one of four classes (high, moderate, low, or negligible value; Table 41.1-2).

The assessments of habitat value for terrestrial and freshwater habitats were conducted using (1) the dataset of breeding landbird observations recorded during point-count surveys in the Cook Inlet drainages study area in 2005 (no shorebirds were observed during point-count surveys in terrestrial and freshwater habitats; see Section 41.5), and (2) habitat-use information from the published and unpublished literature on shorebirds and landbirds. Because project-specific data from the point-count surveys in the study area were limited to three of the nine landbird species of concern, most of the habitat-value assessments for landbirds, and all of the assessments for shorebirds, were based primarily on habitat-use information from the published and unpublished literature on these species; this information was supplemented, when necessary, by professional judgment based on observations of habitat use by these species elsewhere in southwestern and south-central Alaska.

To derive habitat-use information for landbirds in terrestrial and freshwater habitats, each point-count location from 2005 was assigned a mapped habitat in GIS that was defined by the wildlife habitat map polygon that each point-count location occurred in. This was done for all point-count locations in the Cook Inlet drainages study area. Average-occurrence figures then were calculated for the landbird observations that occurred in each mapped habitat (Appendix 41.1A). Using average occurrence (defined as the number of birds observed divided by the number of point-count surveys) corrects for the different numbers of point-counts conducted in each habitat. This standardizes the abundance data across habitats and allows direct comparisons of relative bird abundance among habitats. In calculating average-occurrence figures, only those observations recorded in the focal habitat at each point count were used. Observations made in non-focal habitats (habitats adjacent to the focal habitat at an individual point-count location) were not used because those observations may be biased towards the more vocal and/or more active species. This is because the observations in non-focal habitats are typically made at some distance from the point-count location, so the less vocal and less active species may be missed and inclusion of data from non-focal habitats may downwardly bias the average-occurrence figures for such species.

Because few observations of landbird species of concern in the study area were available for analysis, each observation of a species occurring in a mapped habitat (including incidental observations made during the point-count surveys; see Section 41.5) generally resulted in ranking the habitat in question as high value for that species. Exceptions to this occurred for two species (Olive-sided Flycatcher and Blackpoll Warbler). For these species, although habitats in the Cook Inlet drainages study area were being used, the habitat quality clearly was not high as indicated by the general paucity of observations of these species in the study area (see Section 41.5). In these cases, the habitats observed to be used by these two species were ranked as moderate value only. Similarly, for other uncommon species (e.g., Spruce Grouse, ptarmigan, and shorebirds that were not observed in the study area), no habitats were treated as high value because the forested and open terrestrial habitat patches that could be used by these species in the Cook Inlet drainages study area are typically small in size, and therefore of lower quality, than the breeding habitats used by these species elsewhere in southwestern Alaska.

For marine habitats, site-specific observations of migrant and wintering shorebirds recorded during surveys for marine birds and mammals in the Cook Inlet marine study area (see Chapter 44) were used to assess habitat value for the 12 shorebird species addressed in this study. These observational data were overlaid on the mapped marine habitats to determine the habitats being used at the time of observation. Evaluations of the probable use of additional habitats, which were not observed to be used during the surveys reported in Chapter 44, were made based on (1) known habitat associations (as reported in the scientific literature) for these 12 shorebird species in south-central Alaska, and specifically in the Cook Inlet area when possible; and on (2) field experience with these shorebird species in marine habitats during the nonbreeding seasons in south-central Alaska.

The nine landbird species of concern addressed in this study do not occur in marine habitats and no evaluations of use of marine habitats were made for these species.

41.1.7 Results and Discussion

41.1.7.1 Wildlife Habitat Availability

The Cook Inlet drainages study area designated for wildlife habitat mapping encompasses 15.7 square kilometers. From the pass above the Summit Lakes area in the Chigmit Mountains to Iniskin Bay, the study area primarily is comprised of steep middle to lower coastal mountain slopes, often covered in tall-alder scrub. The area is dissected by a number of upper perennial streams and marine-influenced habitats occur along the shorelines of Iliamna and Iniskin bay. Roughly two-thirds of the study area (10.7 square kilometers) is comprised of terrestrial and freshwater habitats; marine-influenced habitats, including supratidal, intertidal, and subtidal areas occur in the remaining 5.0 square kilometers.

Terrestrial and Freshwater Habitats

Twenty terrestrial or freshwater habitat types were mapped in the Cook Inlet drainages study area (Figures 41.1-1 and 41.1-3). The terrestrial and freshwater habitat types are described in Appendix 41.1B and summaries of the areal coverage of each type in the area are presented in Table 41.1-3. The study area is strongly dominated by one habitat type (Upland Moist Tall Alder Scrub), which accounts for 8.6 square kilometers or 80.0 percent of the study area. Three other types (Upland Dry Barrens, Upland Moist Dwarf Scrub, and Alpine Dry Barrens) cover another 1.5 square kilometers or 14 percent of the study area. The remaining 16 habitat types, including forest, scrub, scrub-bog, meadow, marsh, and freshwater aquatic habitats are uncommon, covering 0.1 square kilometers (0.9 percent of the study area) or less each. Throughout the study area, Upland Moist Tall Alder Scrub frequently is interspersed with Upland Dry Barrens and Upland Moist Dwarf Scrub where raised mountain ridges have exposed well-drained and bare bedrock substrates. Alpine Dry Barrens occurs primarily west of Williamsport where the study area rises to the mountain pass above Summit Lakes. Most of the remaining habitats are scattered throughout the study area, although the forest, scrub-bog, meadow, and marsh habitats are concentrated largely in the Knoll Head area.

The freshwater aquatic habitats in the study area include Lakes and Ponds and both anadromous and non-anadromous Rivers and Streams. The Rivers and Streams are all high-gradient, upper perennial waters with narrow or non-existent riverine habitat fringes. The few Lakes and Ponds have formed on exposed, scoured bedrock ridges in the Knoll Head area and tend to be associated with other wetland habitats including Lowland Sedge–Forb Marsh, Lowland Wet Graminoid–Shrub Meadow, and Lowland Ericaceous Scrub Bog.

Marine Habitats

Seventeen marine habitats were mapped in the Cook Inlet drainages study area (Figures 41.1-2 and 41.1-3). The marine habitat types are described in Appendix 41.1C and summaries of the areal coverage of each habitat type in the study area are presented in Table 41.1-4. The only vegetated marine habitat in the study area is Protected Estuary, which occurs primarily in supratidal areas and is dominated by salt-tolerant vegetation (some small portions of this habitat type also occur in lower intertidal areas). Protected Estuary is uncommon in the area, comprising less than 0.1 square kilometer (less than 1 percent of the study area). Another prominent habitat occurring in supratidal areas is Supratidal Cliff, which was mapped as a line and extends along the shore for nearly the entire length of the study area (27.4 kilometers). The study area, as mapped at mean lower low water, is dominated by nearshore marine waters, with two habitats (Shallow and Deep Subtidal Waters) comprising 2.5 square kilometers or 50.0 percent of the study area. Three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) also are prominent, and together comprise 2.0 square kilometers or 39.0 percent of the study area. Other habitats that individually account for greater than 1 percent of the study area include the protected and exposed forms of Rocky Cliff with Gravel/Sand Beach, Protected Gravel/Sand Beach, and Exposed Rocky Ramp–Platform. These habitats together account for 0.4 square kilometers or 7.6 percent of the study area. The remaining habitats include various forms of Rocky Cliff, Rocky Ramp–Platform, and Gravel/Sand Beach, and are uncommon in the study area; these habitats individually account for less than 0.1 square kilometer (less than 1 percent of the mapped area).

41.1.7.2 Habitat-value Assessments

Habitat values for 39 bird and mammal species of concern that occur in terrestrial or freshwater habitats were assessed for each of the 20 terrestrial or freshwater habitats mapped in the Cook Inlet drainages study area; 26 bird species and 13 mammal species were evaluated (Appendix 41.1D). Using this set of 39 species, researchers assessed the overall wildlife value of each of the terrestrial or freshwater habitats in the study area by determining the number of species (species richness) of birds and mammals with moderate- or high-value rankings in each mapped habitat (Figures 41.1-4 and 41.1-5). This analysis of species richness by habitat indicates that the two forested habitats (Upland and Lowland Spruce Forest, and Upland and Lowland Moist Mixed Forest) have the highest numbers of bird and mammal species of concern with moderate- or high-value habitat rankings (17–18 species; Figure 41.1-4). These forested habitats, however, are uncommon in the study area, occurring primarily in the Knoll Head area (Figure 41.1-5), and together cover less than 0.1 square kilometer (less than 1 percent of the study area). Six other habitats have relatively high numbers of bird and mammal species with moderate or high habitat rankings (11–15 species); these habitats include Rivers and Streams (Anadromous) and five low- and tall-scrub and meadow habitats in upland and riverine areas. These habitats also are uncommon in the study area, together comprising 0.2 square kilometers (1.7 percent of the study area). Another nine habitats have lower numbers of species with moderate or high habitat rankings (six–10 species); these habitats include Rivers and Streams, Lakes and Ponds, marsh, meadow, and scrub-bog habitats in lowland areas, and four dwarf- and tall-scrub habitats in upland and alpine settings. The most common terrestrial or freshwater habitat in the study (Upland Moist Tall Alder Scrub) is in this set of habitats and has 10 species with moderate or high habitat rankings. Three barren habitats in alpine, upland, and riverine areas have the fewest numbers of bird and mammal species with moderate or high habitat rankings (one–four species).

Similarly, for the marine portions of the Cook Inlet drainages study area, habitat values for 43 bird and mammal species of concern that are known to use marine habitats were assessed for each of the 17 marine habitat types mapped; 31 bird species and 12 mammal species were evaluated (Appendix 41.1E). This analysis of species richness by habitat indicates that two marine habitats (Protected Mud Flat and Protected Sand Flat) have the greatest numbers of bird and mammal species of concern with moderate- or high-value habitat rankings (26–27 species each; Figure 41.1-6). These soft-sediment intertidal habitats are common in the study area and occur most prominently in the upper portions of Iliamna and Iniskin bays and, to a lesser extent, at Knoll Head (Figure 41.1-7). Eight other habitats have relatively high numbers of bird and mammal species with moderate or high habitat rankings (12–19 species); these habitats include Protected Estuary, Exposed Sand Flat, both Shallow and Deep Subtidal Waters, the exposed and protected forms of Gravel/Sand Beach, and the protected forms of Rocky Cliff and Rocky Ramp–Platform when associated with Gravel/Sand Beach. Another seven habitats have the fewest numbers of bird and mammal species with moderate or high habitat rankings (three–eight species); in this set are both the exposed and protected forms of Rocky Cliff and Rocky Ramp–Platform, the exposed forms of Rocky Cliff and Rocky Ramp–Platform when associated with Gravel/Sand Beach, and Supratidal Cliffs.

In the sections below, the habitat-value assessments for each of the 61 individual bird and mammal species of concern in the Cook Inlet drainages study area are described.

Mammals

Wolf. The wolf is a generalist species that may be found in most habitats from alpine areas to the coast. Wolves feed on a variety of prey including moose, caribou, beaver, hare, porcupine, salmon, and small mammals, and their use of habitats is largely dependent on the presence of prey in suitable numbers. Moose, caribou, and beaver are thought to be the main prey species for wolves in the northern Bristol Bay region (Woolington, 2006). Caribou probably rarely, if ever, occur in the Cook Inlet drainages study area, but moose are present year-round in low densities (see Section 41.2).

A landscape-scale study of habitat use by wolves was conducted in the boreal forest region in Minnesota (Mladenoff et al., 1995) where wolf packs were found to use greater proportions of mixed forest and forested wetlands and lower proportions of agricultural lands, deciduous forest, and large lakes. Wolves also avoided areas with high road densities and preferred areas with complex patch boundaries.

Wolf packs typically stay within their territories year-round, but some wolves may follow caribou herds (Frame et al., 2004). Wolf numbers in Game Management Unit (GMU) 9, which encompasses the Cook Inlet drainages study area, appeared to have been rising during the early part of this decade (Butler, 2006) but, in view of the continuing decline in the size of the Mulchatna caribou herd (Woolington, 2007a), wolf numbers probably have declined since then.

No wolves were observed during wildlife surveys in the Cook Inlet drainages study area in 2004 and 2005 (see Section 41.2). Most of the habitats in the region of the Pebble Project provide moderate-value wolf habitat, supporting one or more prey species favored by wolves. Alpine and open upland areas support caribou, arctic ground squirrels, and ptarmigan; upland tall-scrub habitats support moose in fall and early winter; and riverine and lower elevation forested areas will be used as winter habitat by moose. Wolves also have been observed feeding on salmon in anadromous streams (Darimont et al., 2003). Wolves may use coastal areas as travel corridors, but generally are not abundant at the coast and do not make extensive use of marine habitat types.

Because the wolf is a generalist species and can use a wide variety of habitats, no individual terrestrial or freshwater habitat in the Cook Inlet drainages study area was considered to be of high value and neither was any habitat considered to be of negligible value. A set of 13 terrestrial/freshwater habitats was considered to be of moderate value for wolves and the remaining seven habitats were categorized as low value (Appendix 41.1D). All marine habitats in the study area were considered to be of low or negligible value for wolves (Appendix 41.1E).

Red Fox. The red fox is the most widely distributed carnivore in the world and is able to live in a wide variety of habitats as long as suitable prey is available (Lariviére and Pasitschniak-Arts, 1996). Red foxes in the study area probably feed on small mammals, snowshoe hares, ptarmigan, grouse, squirrels, berries, eggs, and carrion (Dibello et al., 1990; Lariviére and Pasitschniak-Arts, 1996; Woolington, 2007b). In areas where their ranges overlap, red fox distribution may be affected by avoidance of coyotes (Voigt and Earle, 1983; Van Etten et al., 2007). Their distribution is also affected by snow conditions which can influence fox mobility and access to prey.

Studies of habitat use by red foxes have been conducted in Switzerland (Weber and Meia, 1996) and Yellowstone National Park (Van Etten et al., 2007), where foxes preferred forests. On Prince Edward Island, Canada (Silva et al., 2009), however, foxes avoided forests. These different habitat-use patterns were related to differing prey availability, threat of human harvest, and snow cover. In Maine, red foxes hunted small mammals when snow was shallow but switched to snowshoe hare when snow was deep or heavily crusted (Halpin and Bissonette ,1988).

Based on trapper questionnaire data, the red fox is the most prevalent furbearer species in GMU 9, although their perceived abundance declined from 2003 to 2006 and is influenced by periodic rabies epizootics (Butler, 2007). Beavers, however, also are common in appropriate aquatic habitats in southwestern Alaska and are known to be locally abundant in parts of GMU 9 (e.g., in the mine study area; see Chapter 16, Section 16.2).

Red foxes are expected to be present in most habitats in the region of the Pebble Project that provide adequate vegetation cover and potential prey. Given the presence of coyotes, however, which prey on foxes, foxes are less likely to frequent open areas. Small mammals and berries will be present in many different habitats, hares will be in riverine and forested areas, waterfowl will be present near lacustrine waterbodies, and moose carcasses may be most available in riverine areas during winter.

Because the red fox, like the wolf, is a generalist predator and can use a diversity of habitats, no individual terrestrial or freshwater habitat in the Cook Inlet drainages study area was considered to be of high value and neither was any habitat considered to be of negligible value. A set of 10 terrestrial/freshwater habitats was considered to be of moderate value for red foxes and the remaining 10 habitats were categorized as low value (Appendix 41.1D). All marine habitats in the study area were considered to be of low or negligible value for red foxes (Appendix 41.1E).

Sea Otter. Sea otters inhabit marine environments year-round. In the Cook Inlet marine study area, which is much larger than the area mapped for marine habitats in this study, sea otter population densities show large seasonal fluctuations, with the highest densities occurring in winter and very low densities in summer (see Chapter 44). Sea otters forage exclusively in subtidal and intertidal marine waters, where they feed on a variety of mollusks, crustaceans, other invertebrates, and nearshore fishes (Riedman and Estes, 1990). Based on the data collected during marine wildlife surveys (see Chapter 44), sea otters have been observed primarily in subtidal waters in the Cook Inlet drainages study area. Sea otters occasionally haul out to rest in intertidal and even supratidal habitats, but do not use terrestrial habitats. In the larger Cook Inlet marine study area, most hauled-out sea otters have been observed on islands at the mouth of Iniskin Bay (Chapter 44) rather than on the mainland, where their exposure to terrestrial predators would be greater.

In the Cook Inlet drainages study area, two marine habitats (Shallow and Deep Subtidal Waters) were considered to be of moderate value for sea otters (Appendix 41.1E). The remaining 16 marine habitats were considered to be of either low or negligible value.

River Otter. River otters are tied closely to productive aquatic habitats, feeding heavily on fishes (Reid et al., 1994a; Larivière and Walton, 1998). Winter habitat availability may be a key factor for determining carrying capacity and ice cover and low temperatures may limit forage opportunities (Reid et al., 1994). River otters require suitable shorelines for winter denning, preferring beaver-influenced lakes and ponds with banked shores and burrows (Reid et al., 1994b; Larivière and Walton 1998; LeBlanc et al., 2007). River otters prefer dense vegetation and avoid open fields (Bowyer et al., 1995; Gallant et al., 2009). In the marine environment, river otters forage along the shoreline, feeding primarily on slow-moving, moderately sized fishes (Larsen, 1984; Stenson et al., 1984; Cote et al., 2008).

River otters occur primarily in aquatic habitats and adjacent, associated habitat types. Lakes, ponds, and rivers are used for foraging, and nearby areas are used for travel, cover, and denning. River otters in marine areas use habitats along the coastal fringe and forage in intertidal and nearshore subtidal waters (Bowyer et al., 1995; Ben-David et al., 1996).

In the Cook Inlet drainages study area, three freshwater habitats (Rivers and Streams, Rivers and Streams [Anadromous], and Lakes and Ponds) were considered to be of high value for river otters (Appendix 41.1D). A set of four associated riverine habitats were considered to be of moderate value. The remaining terrestrial habitats were considered to be of either low or negligible value. One marine habitat (Shallow Subtidal Waters) was considered to be of moderate value for river otters and the remaining marine habitats were categorized as low or negligible value (Appendix 41.1E).

Wolverine. Wolverines have a circumpolar distribution but occur at low densities and are sensitive to human disturbance (Pasitschniak-Arts and Larivière, 1995; May et al., 2006). Wolverines have large home ranges and take a broad range of foods, consisting mostly of small mammals and birds, but also including carrion and occasionally preying on larger mammals (Pasitschniak-Arts and Larivière, 1995). In questionnaires, trappers in GMU 9 rated wolverine as having a low but stable population (Butler, 2007).

Wolverines use a variety of different habitats but, due to their low abundance, few habitat studies are available. Wolverines in the middle Susitna River basin of southcentral Alaska moved to higher elevations during summer than in winter and tended to use broad habitat categories (forest, shrub, rock/ice) in relation to availability, although they avoided forest in summer and high-elevation tundra habitats in winter (Whitman et al., 1986). This pattern may have resulted from the availability of arctic ground squirrels and other small mammals in alpine habitats in summer and moose and caribou carcasses at low elevations in winter (Whitman et al., 1986). Banci and Harestad (1990) found that wolverines used habitat classes in proportion to their availability in southwest Yukon, where few small mammals were available in alpine habitats. Copeland et al. (2007) reported that wolverines in Idaho favored higher elevation areas during the summer but showed little selection for specific habitat types. Rock and grass–shrub habitats were avoided, especially during the winter. Krebs et al. (2007) found that wolverine habitat selection in British Columbia varied by sex and season, but in general wolverines selected alpine areas and avalanche chutes, where marmots and ground squirrels were plentiful in summer, and moose winter range in winter. Both sexes avoided areas used for winter recreation.

Wolverines are expected to use virtually all of the habitats in the region of the Pebble Project. Alpine and upland areas with large numbers of arctic ground squirrels may be important in the summer, and lower elevation forested and riverine areas may be more important in the winter when moose carcasses are present. Wolverines likely are rare in coastal habitats.

Because the wolverine is a generalist predator known to use many different habitats, no individual terrestrial or freshwater habitat in the Cook Inlet drainages study area was considered to be of high value and neither was any habitat considered to be of negligible value. A set of 14 terrestrial/freshwater habitats was considered to be of moderate value for wolverines and the remaining six habitats were categorized as low value (Appendix 41.1D). All marine habitats in the study area were considered to be of low or negligible value for wolverines (Appendix 41.1E).

Harbor Seal. Harbor seals are year-round inhabitants of the marine coastal environment, often concentrating in estuaries and protected bays, and do not use terrestrial habitats. They forage in subtidal and, to a lesser degree, intertidal waters, feeding mainly on a variety of nearshore benthic fishes, as well as octopus, squid, and shrimp (Hoover, 1988). Harbor seals haul out to rest in a range of habitats, including cobble and sand beaches, tidal mudflats, offshore rocks and reefs, glacial and sea ice, and occasionally even manmade objects (Hoover, 1988). They tend to use haulouts that offer protection from terrestrial predators, easy access to deep water and proximity to food, and protection from wind and waves. Nearly all of the haulout sites used by harbor seals in the Cook Inlet marine study area are located on offshore rocks and islands, although exposed tidal mudflats are used in the middle portions of the bays (see Chapter 44). Seals do not haul out on the mainland in the habitat-mapping corridor.

In the Cook Inlet drainages study area, two marine habitats (Shallow and Deep Subtidal Waters) were considered to be of high value for harbor seals (Appendix 41.1E). A third habitat (Protected Sand Flat) was considered to be of moderate value based on the observed use of this habitat (at high tide) during surveys for marine wildlife (see Chapter 44). The remaining 14 marine habitats were considered to be of either low or negligible value.

Black Bear. Black bears are known to avoid open habitats and occur most commonly in forest and scrub habitats (Holm et al., 1999). In the Cook Inlet drainages study area, black bears were recorded primarily in forested areas (see Section 41.2). In areas where brown bears also occur, black bears typically avoid habitats used consistently by brown bears, such as salmon-spawning streams; in such areas, there is an inverse relationship between brown bear density and the proportion of salmon in black bear diets (Belant et al., 2006), and hence, black bears are largely herbivorous and frugivorous when they occur sympatrically with brown bears (Jacoby et al., 1999; Belant et al., 2006; Fortin et al., 2007).

After emergence from dens in spring, black bears seek newly emerging green vegetation such as horsetails (*Equisetum* spp.), grasses, and sedges (*Carex* spp.), which are high in protein and easily digestible. Overwintered berries from the preceding fall are eaten where available. Animal foods are sought at any time of year, but the carcasses of winter-killed animals and the newborn calves of ungulates can be particularly important supplemental foods in spring. The nutrient quality of green vegetation decreases as it matures in summer, causing bears to switch to other plant species such as claspleaf twistedstalk (*Streptopus amplexifolius*), rusty menziesia (*Menziesia ferruginea*), and common cowparsnip (*Heracleum maximum*), as well as insects (ants, wasps, beetles), and salmon when spawning runs begin (if brown bears are not present). Bears begin to eat berries and fruit as they begin to ripen in midsummer and continue feeding heavily on berries and fruit throughout the fall to store up energy for winter dormancy.

In the region of the Pebble Project, black bears are most numerous east of Iliamna Lake and in some areas near Cook Inlet (see Section 41.2). They often are found in high-elevation alder patches and mixed forest where there is abundant cover and forage in small clearings. Given the high densities of brown bears in the Pebble area, it is likely that black bears are largely excluded from salmon streams in late summer and from open areas away from escape cover during all seasons. Black bears may use coastal areas and feed in intertidal zones when brown bears are not present (Carlton and Hodder, 2003).

In the Cook Inlet drainages study area, three terrestrial habitats (Upland Moist Tall Alder Scrub, Upland and Lowland Moist Mixed Forest, and Riverine Tall Alder or Willow Scrub) were considered to be of high value for black bears (Appendix 41.1D). A set of eight other forest, scrub, scrub-bog, meadow, and marsh habitats, and Rivers and Streams (Anadromous) were considered to be of moderate value. Only one of these high- and moderate-value habitats (Upland Moist Tall Alder Scrub) is common in the study area.

The remaining terrestrial/freshwater habitats were considered to be of either low or negligible value. Overall, suitable terrestrial and freshwater habitats (those with moderate or high habitat-value rankings) for black bears are common and widespread in the Cook Inlet drainages study area (Figure 41.1-8). All marine habitats in the study area were considered to be of low or negligible value for black bears (Appendix 41.1E).

Brown Bear. A rigorous population survey conducted over two spring seasons in GMU 9A, which includes the Cook Inlet drainages study area, resulted in an estimated density of 150 brown bears per 1,000 km² (Olson and Putera, 2007). This is far higher than the brown bear density of approximately 48 bears per 1,000 km2 found in a recent survey in a broad area surrounding Iliamna Lake (Becker, 2010). Bears in the region of the Pebble Project use a variety of seasonal resources. In spring and early summer, large concentrations of bears are present in sedge meadows along the coast foraging on vegetation. During summer and early fall, brown bears concentrate along salmon-spawning streams. Bears also feed on ground squirrels, moose and caribou calves, and berries when available. In late fall and early winter, bears excavate winter dens.

Habitat selection by brown bears varies by season, sex, and by the scale of detection (Ciarniello et al., 2007). In a detailed study of habitat use in mountainous areas of southeastern British Columbia (an area with that has habitats similar to those found in the Cook Inlet drainages study area), bears were more often detected in high-elevation areas with relatively steep slopes, rugged terrain, and low human access; areas that were used had more avalanche chutes, alpine tundra, barren areas, and burned and older forests (Apps et al., 2004). In Wyoming, male brown bears used open areas preferentially and were largely nocturnal, whereas female bears were crepuscular (Holm et al., 1999). In Alaska, adult female brown bears in the Kuskokwim Mountains moved to lower elevation areas near anadromous streams in mid-July to mid-August, and then moved to higher elevations during September for foraging and later for denning; in the Kuskokwim Mountains study area, there was an inverse relationship between salmon availability and the distance of bears to salmon streams (Collins et al., 2005).

Early season herbaceous vegetation in coastal saltmarshes, such as sedges (*Carex* spp.), grasses (*Elymus* spp.), and forbs (*Plantago* spp. and *Triglochin* spp.), provide a highly digestible, abundant source of protein (Bennett, 1996; Rode et al., 2001). Brown bears travel along coastal beaches and may augment forage plants with clams during favorable low tides (Carlton and Hodder, 2003; Smith and Partridge, 2004). Bears in alpine areas of Kodiak Island fed heavily on *Carex macrochaeta* in *Carex*–forb meadows (Atwell et al., 1980).

Use of salmon streams varies by sex and by the abundance of salmon. Bear-viewing sites with low salmon capture rates and no waterfalls had low use by adult males. Use of bear-viewing sites by female bears with dependent young was significantly related to the prevalence of adult males (Rode et al., 2006).

On Kodiak Island, brown bears denned most often in alder–willow thickets at elevations ranging from 30–1006 meters (100–3,300 feet) asl (Lentfer et al., 1972). Bears on Admiralty Island in southeast Alaska frequently denned in rock caves at high elevations and bears on Chichagof Island excavated dens under bases of large spruce or snags in old-growth forest (Schoen et al., 1987). Bears enter dens later in areas with late salmon runs (Schoen et al., 1987, Van Daele et al., 1990). Terror Lake bears on Kodiak Island selected steep alpine slopes for dens, whereas southwestern Kodiak bears selected moderate midslope habitats, usually within or at the edges of alder thickets, where root systems stabilized the dens; use of lowlands was less than the availability in both areas (Van Daele et al., 1990).

The vegetation at bear denning locations in the Talkeetna Mountains was alpine tundra (52 percent), shrubs (alder, willow, or birch [*Betula* spp.]; 35 percent), tussock grass and rocks (13 percent); females with cubs of the year remained at high elevations for 2–5 weeks after emergence, presumably to decrease risk to young cubs (Miller, 1990). Female bear dens on the Kenai Peninsula were located in high elevation areas with steep slopes and away from human disturbance (Goldstein et al., 2010). Ciarniello et al. (2005) found that in the mountains of British Columbia, bears denned in excavations into sloping ground (74 percent) or natural caves (26 percent), whereas 90 percent of bears in a lower plateau excavated dens under the bases of trees. Bears on the plateaus preferred to den in stands with tall trees and away from roads.

Brown bears in the region of the Pebble Project use different habitats at different times of year. They den most frequently at high elevations and often feed on arctic ground squirrels in the spring. Riverine and forested areas also may be used for travel corridors and for hunting moose calves. Coastal sedge meadows and mudflats can support very high densities of bears in early summer. In mid- and late summer, brown bears congregate at salmon-spawning streams throughout the region. They occur commonly along coastal beaches, especially near the mouths of rivers with spawning runs of anadromous fishes.

In the Cook Inlet drainages study area, only one freshwater habitat (Rivers and Streams [Anadromous]) was considered to be of high value for brown bears because of the concentrated foraging that can occur along salmon streams in mid- and late summer (Appendix 41.1D). Because brown bears are known to use a wide variety of habitats for foraging and denning, another 15 terrestrial/freshwater habitats in the study area were considered to be of moderate value. Only one of these high- and moderate-value habitats (Upland Moist Tall Alder Scrub) is common in the study area. The remaining four terrestrial/freshwater habitats were considered to be of low value. Overall, suitable terrestrial and freshwater habitats (those with moderate or high habitat-value rankings) for brown bears are common and widespread in the Cook Inlet drainages study area (Figure 41.1-8).

Five marine habitats in the study area (Protected Estuary, Protected Gravel/Sand Beach, Protected Rocky Cliff with Gravel/Sand Beach, Exposed Gravel/Sand Beach, and Exposed Rocky Cliff with Gravel/Sand Beach) were considered to be of moderate value for brown bears for foraging (Appendix 41.1E). With the exception of Protected Estuary, which only occurs in two small areas, these moderate-value marine habitats are relatively common in the study area. The remaining marine habitats in the study area were considered to be of low or negligible value. Overall, suitable marine habitats (those with moderate habitat-value rankings) for brown bears are relatively common in the Cook Inlet drainages study area (Figure 41.1-8).

Harbor Porpoise. Harbor porpoises use marine habitats exclusively. Harbor porpoises tend to forage singly or in small groups on a variety of small fishes, such as herring and capelin, and squid (Reeves and Read, 2004). In the marine wildlife study area, harbor porpoises have been seen mostly in the spring, during the herring-spawning season (see Chapter 44); they were recorded infrequently in both Deep and Shallow Subtidal Waters in the Cook Inlet drainages study area.

In the Cook Inlet drainages study area, one marine habitat (Deep Subtidal Waters) was considered to be of moderate value for harbor porpoises (Appendix 41.1E). Shallow Subtidal Waters was considered to be of low value and the remaining 15 marine habitats were categorized as negligible value.

Moose. Moose habitat requirements vary seasonally and geographically in relation to the availability of forage and specific nutrients, protection from predators, and refuge from deep winter snow. Productive seral shrub areas provide high-quality forage, aquatic habitats provide important nutrients such as sodium and early emerging, high-quality spring vegetation (MacCracken et al., 1993; Kellie, 2005), and mature forests with closed canopies provide lower snow depths in winter. Some of the best moose habitat is found in forests disturbed by flooding, fire, insect outbreaks, or logging (Telfer, 1978; Loranger et al., 1991; Forbes and Theberge, 1993). Deltas and floodplains are especially productive moose habitat (LeResche et al., 1974; Telfer, 1984; MacCracken et al., 1997) due to the large proportion of early successional shrub habitats created by continuous shifts in vegetation. In mountainous areas, high-elevation shrub communities are a highly productive and stable habitat (Telfer, 1984) when not covered by deep snow. Home-range sizes tend to be larger in areas with more non-preferred habitat (Herfindal et al., 2009).

Because different habitats fulfill different requirements for moose survival (e.g., forage, cover) and the utility of each habitat type varies seasonally and according to different abiotic factors such as snow depth and fire frequency, moose require areas with a variety of different habitat types. Maier et al. (2005) found that moose densities in interior Alaska were highest in burned areas 11–30 years old, near towns, near rivers, in areas of moderate elevations, and in large compact areas of varied habitats. Moose densities were lower in areas of variable terrain and unvegetated areas. A portion of most moose populations migrate seasonally to reach optimal habitat types at different times of year. Males and females may prefer different habitats in some seasons due to their different body sizes, nutritional requirements, and susceptibility to predation (Miquelle et al., 1992).

In spring, moose seek out high-quality forage to compensate for the negative energy balance that occurs during severe winters. Moose in Alaska exhibit high fidelity in early spring to areas with abundant aquatic vegetation, which typically greens-up earlier than terrestrial vegetation (MacCracken et al., 1997; Kellie, 2005)

During calving, female moose look for areas that balance the need for abundant forage with protection from predators. Maternal moose often make rapid movements to new areas just before calving (Bowyer et al., 1999; Testa et al., 2000; Kellie, 2005) and then remain near the calving sites for an extended period of time (Bowyer et al., 1999; Testa et al., 2000). Many moose calve in isolated pockets of dense forage near water, but some move to high elevations during calving (Poole et al., 2007). Miquelle et al. (1992) found that moose typically calved in areas with spruce–aspen (*Populus tremuloides*) or birch–willow habitats, whereas males used areas of upland willow. Bowyer et al. (1999) reported that moose calving locations were distributed randomly with respect to habitat, but that moose selected locations for microsite characteristics such as forage availability and aspect. Kellie (2005) found that moose used open areas prior to calving then moved to areas of denser cover during parturition but showed no fidelity to specific calving locations.

During summer, moose have many options for high-quality forage and therefore use a wide variety of habitat types. In most moose populations, summer browse is not a limiting factor. During fall, moose congregate in specific rutting areas. Males search out females and, in some areas, gather harems of females (Molvar and Bowyer, 1994). Cows with calves may be more solitary during rut. Higher elevations areas with large openings are often preferred rutting areas and may attract moose from surrounding areas. Peek et al. (1976, cited in Peek 1997) found that moose in northern Minnesota used moist lowlands and sparsely stocked forest stands during the rut. On the Copper River delta in southcentral Alaska, moose home ranges were located in areas with a high proportion of aquatic and sweetgale–willow habitats. Within home ranges, moose selected areas with tall alder-willow habitats (MacCracken et al., 1997).

In mountainous areas, moose use low-elevation areas almost exclusively during winter due to deep snow accumulation at higher elevations (Modaferri, 1999). Snow more than 70 centimeters (28 inches) deep limits moose mobility and covers many preferred forage plants (Coady, 1974; Collins and Helm, 1997). In some locations, moose follow specific migratory routes when snow accumulation forces them to lower elevations (Hundertmark, 1997).

Poole and Stuart-Smith (2006) reported that elevation was the strongest determinant of moose winter density in southeastern British Columbia. Various studies have suggested that habitat with mature closed canopies is preferred by moose during winter because the interlocking canopy intercepts snow (Pierce and Peek, 1984; Forbes and Theberge, 1993) but access to adequate winter forage also is important. Collins and Helm (1997) found that areas of old poplar forest and birch–spruce forest were used in winter when snow depths were below 110 centimeters (42 inches); when snow was deeper, areas with abundant feltleaf willow (*Salix alaxensis*) were used. Similarly, Collins (2002) noted that moose used riverine feltleaf willows in years of deep snow but used the more abundant diamondleaf willow (*S. pulchra*) on hillsides when snow depth was lower.

Miquelle et al. (1992) reported different habitat selection by male and female moose during winter in interior Alaska. Males used upland willow in years with deep snow and alluvial willow in years with low snow depth. Females predominately used spruce–aspen forest in all winters of the study. Collins and Helm (1997) found that moose used areas of mature white spruce in late spring, possibly to take advantage of the shade during warm days. Suring and Sterne (1998) found that, during deep-snow winters, moose on the Kenai Peninsula used deciduous forest and tall alder–willow communities and avoided mixed deciduous–coniferous forest, sweetgale, and herbaceous–grass communities. During a late-winter moose survey of the Pebble area in April 2010, when snow cover was relatively shallow, all moose observed were below 335 meters (1,100 feet) elevation and the highest densities were in low-elevation areas near the Pile River and Chekok Creek (see Chapter 16, Section 16.7).

Moose populations are limited by either predators or forage availability. Limiting factors differ in different part of the range of moose and include winter habitat, summer habitat, calf predation, and adult predation. In areas with high predator populations, such as in the region of the Pebble Project, predation and not forage typically is the limiting factor (Testa, 2004). The Pebble region has a high brown bear population and a sizeable wolf population (~350 wolves in GMUs 9 and 10; Butler, 2006). The number of moose calves observed in GMU 9B was low, at 19 calves:100 cows in fall 2005 and 2 calves:100 cows in fall 2007 (Butler, 2008). Observations suggest that calf predation and occasional winters with deep snow may be limiting the moose population in the area. A minimum calf-cow ratio of 31.8 calves:100 cows was observed during the moose survey conducted in spring 2010 in the Pebble area (see Chapter 16, Sections 16.2 and 16.7), but the sample size was low (38 moose).

Moose distribution in the region of the Pebble Project is heavily influenced by snow cover and elevation. Moose calve in riverine and forested areas in spring and may use lakes and ponds for early emergent vegetation and nutrients. Higher elevation tall-scrub habitats are used in fall and during the rut, and then moose move to lower elevations when snow depth becomes too high at higher elevations. Riverine willows are especially important for moose during winter. In the Cook Inlet drainages study area, moose are most likely to be found in low-elevation areas of large river valleys and on the Iniskin Peninsula (see Section 41.2, Figure 41.2-3). Marine habitat types are used very little by moose.

In the Cook Inlet drainages study area, three low and/or tall willow-scrub habitats in upland and riverine settings and Lakes and Ponds were considered to be of high value for moose (Appendix 41.1D), primarily for forage. Another seven scrub, scrub-bog, forest, meadow, and freshwater marsh habitats were considered to be of moderate value, also for forage. Only one of these high- and moderate-value habitats (Upland Moist Tall Alder Scrub) is common in the study area. All other terrestrial/freshwater habitats were considered to be of low or negligible value. Overall, suitable terrestrial and freshwater habitats (those with moderate or high habitat-value rankings) for moose are common and widespread in the Cook Inlet drainages study area (Figure 41.1-9). All marine habitats in the study area were considered to be of low or negligible value for moose (Appendix 41.1E).

Arctic Ground Squirrel. Arctic ground squirrels inhabit arctic and alpine tundra, where they occur commonly in meadow, riverbank, and lakeshore habitats. They prefer permafrost-free areas with loose soils, good visibility, and an adequate supply of low, early successional vegetation (MacDonald and Cook, 2009). Ground squirrels survive the long winters by putting on large fat reserves during summer and dropping their body temperature below the freezing point of water during winter hibernation (Barnes, 1989; Buck and Barnes, 1999).

Arctic ground squirrels were widely distributed in Katmai National Park (Schiller and Rausch, 1956; Cook and MacDonald, 2004a). In Lake Clark National Park, they were captured along streams in herbaceous vegetation, on boulder slopes with dwarf willow–tussock and grass vegetation, on stream banks with dwarf willows, and near the community of Port Alsworth (Cook and MacDonald, 2004b). They eat a wide variety of plant species including forbs, grasses and grass seed, and legumes, but tend to avoid evergreen shrubs (Batzi and Sobaski, 1980; McLean, 1985). In the Yukon, arctic ground squirrels live both in boreal forests and alpine areas (Hik et al., 2001); the population in boreal forests fluctuated with snowshoe hare cycles because predators switched to alternative prey when hare numbers declined. In contrast, ground squirrels in alpine areas have greater visibility to limit predation and have more stable populations (Karels and Boonstra, 1999).

Arctic ground squirrels in the region of the Pebble Project occur most frequently in open alpine and upland habitats with well-drained soils and good visibility. They also make use of riverbanks and lakeshores. They are uncommon in coastal areas in the Pebble Project region.

In the Cook Inlet drainages study area, a single terrestrial habitat (Upland Dry Dwarf Shrub–Lichen Scrub) was considered to be of high value for arctic ground squirrels (Appendix 41.1D). A set of three other open upland and alpine habitats was considered to be of moderate value. All other terrestrial/freshwater habitats were considered to be of low or negligible value. Arctic ground squirrels do not occur in marine habitats, and marine habitat values were not assessed for this species.

Red Squirrel. Red squirrels are abundant across much of boreal Canada and the northern and western United States. They are largely restricted to coniferous forest but also may use mixed forest (Steele, 1998). They prefer coniferous habitats for the abundant conifer seed, fungi, and interlocking canopies that allow for effective escape from predators and efficient foraging (Steele, 1998). Red squirrels prefer white spruce cones to black spruce cones, presumably for their larger size and higher caloric content (Brink and

Dean, 1966). Red squirrels are highly territorial and collect conifer cones in late summer and autumn and store them in middens. Red squirrel population size was significantly related to the crop of white spruce cones in Alberta (Kemp and Keith, 1970). Red squirrel populations in poplar stands in Alberta were mostly comprised of juveniles that were unlikely to survive the winter (Rusch and Reeder, 1978). Natural cavities in trees are preferred for nest sites, but leaf nests or underground nest cavities also are used.

Primary food items are seeds of trees and fungi, although tree leaf buds and flowers, fleshy fruits, tree sap, bark, insects, bird eggs, juvenile animals, carrion, and birds also are eaten (Steele, 1998). Red squirrels are prey for hawks, owls, and mammalian predators such as lynx and red fox (Steele, 1998).

Within the region of the Pebble Project, red squirrels occur in forested areas, predominantly using dense spruce forests, with lower densities occurring in mixed forests and open spruce forests. Suitable forested habitats are uncommon in the Cook Inlet drainages study area, being restricted mainly to the Iniskin Peninsula near Knoll Head.

In the Cook Inlet drainages study area, two forest habitats (Upland and Lowland Spruce Forest, and Upland and Lowland Moist Mixed Forest) were considered to be of high value for red squirrels (Appendix 41.1D). All other terrestrial/freshwater habitats were considered to be of low or negligible value. Red squirrels do not occur in marine habitats, and marine habitat values were not assessed for this species.

Beaver. The beaver is one of the most common furbearers in the region of the Pebble Project, occurring in freshwater aquatic habitats bordered by woody shrub and forest vegetation. The only aquatic habitats unsuitable for beavers are fast-moving streams and rivers and those with widely varying levels of water flow. Beavers are abundant in the mine study area and lodges were found on most of the suitable ponds, lakes, and streams (see Chapter 16, Section 16.2), but they are less numerous in the transportation-corridor, Bristol Bay drainages study area (Section 16.7) and in the Cook Inlet drainages study area (Section 41.2). The beaver is an ecologically important species whose presence and activities affect the distribution of aquatic and riparian habitats and the abundance of fish and other wildlife species in those areas (Johnston and Naiman, 1987; Mitchell and Cunjak, 2007). Beaver ponds can provide important winter habitat for juvenile salmon (Rosell et al., 2005). Beavers prefer to forage on aspen, balsam poplar (cottonwood), and willow, but also eat birch and alder (Jenkins and Busher, 1979).

In the region of the Pebble Project, beavers occur in rivers, lakes, and ponds, and in adjacent forest and tall-scrub habitats. Beavers build dams, lodges, and food caches in waterbodies, and travel short distances to gather aspen, poplar, willow, and occasionally alder. Other areas may be used for travel to preferred areas or for dispersal of young beavers to new areas.

In the Cook Inlet drainages study area, three freshwater habitats (Rivers and Streams, Rivers and Streams [Anadromous], and Lakes and Ponds) were considered to be of high value for beavers (Appendix 41.1D). Two other riverine scrub habitats and Upland and Lowland Moist Mixed Forest were considered to be of moderate value. All other terrestrial/freshwater habitats were considered to be of low or negligible value. Beavers do not occur in marine habitats, and marine habitat values were not assessed for this species.

Northern Red-Backed Vole. The northern red-backed vole is one of Alaska's most ubiquitous and common mammal species, inhabiting forests, shrublands, alpine tundra, and riparian areas (MacDonald and Cook, 2009). They feed on fungi, berries, succulent green plants, and lichens (Bangs, 1984).

In Lake Clark National Park and Preserve, red-backed voles were sampled in a broad range of vegetation types, but were most abundant in forest and scrub communities (Cook and MacDonald, 2004b). Their distribution appears to be related closely to the presence of overhead plant cover. In Katmai National Park and Preserve, red-backed voles were found in a variety of plant communities including alder–horsetail, spruce–alder–willow, and bluejoint (*Calamagrostis canadensis*) communities (Schiller and Rausch, 1956; Cook and MacDonald, 2004a).

In the southeastern Yukon, overwinter survival was an important determinant of vole population size and was thought to be a function of average snow depth and the presence of dwarf shrub berries, especially crowberry (*Empetrum nigrum*) (Boonstra and Krebs, 2006; Krebs et al., 2010).

In the region of the Pebble Project, northern red-backed voles are likely to be widely distributed in a variety of forest and scrub habitats. Densities are probably highest in mixed forest and spruce forest habitats. Suitable forested habitats are uncommon in the Cook Inlet drainages study area, occurring primarily on the Iniskin Peninsula near Knoll Head.

In the Cook Inlet drainages study area, two forest habitats (Upland and Lowland Spruce Forest, and Upland and Lowland Moist Mixed Forest) were considered to be of high value for northern red-backed voles (Appendix 41.1D). Six other scrub and scrub-bog habitats were considered to be of moderate value and the remaining terrestrial/freshwater habitats were categorized as low or negligible value. All marine habitats in the study area were considered to be of low or negligible value for northern red-backed voles (Appendix 41.1E).

Tundra Vole. Tundra voles (also known as root voles) inhabit a wide variety of open herbaceous habitats at various elevations. Although they can be found in shrublands, tundra, grasslands, and riparian areas, they are most abundant in wet sedge and grass–forb meadows and bogs (MacDonald and Cook, 2009). In northern Alaska, tundra voles reach their highest densities in swales and watercourses with dense, wet sedge meadows dominated by rhizomatous monocotyledons (especially *Carex* spp. and *Eriophorum* spp.), which are their primary food (Bee and Hall, 1956; Batzli and Henttonen, 1990).

In Lake Clark National Park and Preserve, tundra voles were found in grassy areas across a broad range of habitat types and elevations (Cook and MacDonald, 2004b). They were most abundant in scrub and herbaceous habitats and were least abundant in forested habitats. In Katmai National Park and Preserve, they were most common in herbaceous habitats; none were captured in forested habitats. Root voles were abundant along the coast of Cook Inlet in Katmai National Park (Schiller and Rausch, 1956).

Tundra voles in the region of the Pebble Project are expected to occur in wet open habitats dominated by graminoid vegetation; they may occur especially in Riverine Wet Graminoid–Shrub Meadow, Lowland Sedge–Forb Marsh, and Lowland Wet Graminoid–Shrub Meadow. Use of marine habitat types by this species is negligible.

In the Cook Inlet drainages study area, two terrestrial habitats (Riverine Wet Graminoid–Shrub Meadow and Lowland Wet Graminoid–Shrub Meadow) were considered to be of high value for tundra voles (Appendix 41.1D). Seven other scrub, scrub-bog, and marsh habitats were considered to be of moderate value and the remaining terrestrial/freshwater habitats were categorized as low or negligible value. All marine habitats in the study area were considered to be of low or negligible value for tundra voles (Appendix 41.1E).

Snowshoe Hare. When abundant, snowshoe hares have large effects on the ecosystems in which they occur. For example, snowshoe hares can remove a large proportion of the standing shrub biomass (Hodges, 1999). Snowshoe hare populations undergo cyclical fluctuations and predators such as lynx, coyotes, red foxes, Northern Goshawks, and Great Horned Owls show a similar numerical response to changes in hare numbers, often with a lag period. Other small mammals also show cyclical population fluctuations possibly because of food competition or increased predation.

Snowshoe hares select habitats with dense understory cover in boreal coniferous forest, avoiding young re-growth, clearings, and other open areas (Hodges, 1999); dense understory is more important than canopy closure and interspersion of different stand types may be preferred. They are more likely to use deciduous forest types in summer than in winter due to the greater cover afforded by leaves and they may occur in areas of sparse cover mainly during darkness. Open areas may be used more when hare densities are high (Wolff, 1980). Dense understories provide escape cover and thermal protection and were correlated with spring densities and overwinter survival in Maine (Litvaitis et al., 1985).

In southcentral Alaska, snowshoe hares prefer white spruce forest, and alder-, and willow-dominated scrub habitats during winter and early spring. Snowshoe hare pellets from southcentral Alaska contained predominately spruce, willow, Labrador tea (*Ledum groenlandicum*), and dwarf birch (*Betula nana*) with lesser amounts of blueberry (*Vaccinium* spp.), horsetail, and unidentified forbs and grasses (MacCracken et al., 1988); alder was not an important forage species even though it was abundantly available. Habitats used in winters when hare densities are low may be important in supporting remnant populations until hare numbers subsequently increase (Wolff, 1980). GMU 9 is on the edge of the range of snowshoe hares and trappers rated them as moderately abundant with recently stable numbers (Butler, 2007). Cook and MacDonald (2004) found that the snowshoe hare abundance in Katmai National Park was low.

In the region of the Pebble Project, snowshoe hares are most likely to be found in dense cover in forest and in tall willow-scrub habitats. They are not likely to occur in alpine or coastal areas.

In the Cook Inlet drainages study area, two terrestrial habitats (Upland and Lowland Spruce Forest, and Riverine Tall Alder or Willow Scrub) were considered to be of high value for snowshoe hares (Appendix 41.1D). Five other scrub and forest habitats were considered to be of moderate value and the remaining terrestrial/freshwater habitats were categorized as low or negligible value. Snowshoe hares do not occur in marine habitats, and marine habitat values were not assessed for this species.

Tree-nesting Raptors

Habitat availability in the Cook Inlet drainages study area for the four tree-nesting raptors species of concern addressed in this study was assessed spatially in map form (Figure 41.1-10). This figure displays the suitability of habitats (moderate or high habitat-value rankings) for both nesting and foraging tree-nesting raptors considered as a group. Habitat values were assessed for all four species in terrestrial and freshwater habitats and for two of the four species in marine habitats (two species do not use marine habitats).

Two forest habitats (Upland and Lowland Spruce Forest, and Upland and Lowland Moist Mixed Forest) were considered suitable for four tree-nesting raptor species for nesting and/or foraging (Appendix 41.1D). These forest habitats, however, are uncommon in the study area. Other scrub, meadow, marsh, and barren habitats, and Rivers and Streams (both anadromous and nonanadromous types), and Lakes and

Ponds were considered suitable for fewer species; these habitats similarly are uncommon in the study area. Overall, in contrast to the transportation-corridor, Bristol Bay drainages study area (which is largely forested), suitable terrestrial and lacustrine habitats for nesting and foraging tree-nesting raptors are not common in the Cook Inlet drainages study area (Figure 41.1-10). Riverine habitats in the study area also are not common.

Three marine habitats (Protected Mud Flat, Protected Sand Flat, and Shallow Subtidal Waters) were considered suitable for foraging by both of the tree-nesting raptor species assessed for marine habitat values (Appendix 41.1E). Other marine habitats considered suitable for foraging by one of the two tree-nesting raptor species assessed included cliffs, estuarine areas, and Deep Subtidal Waters. Overall, suitable marine habitats for foraging by tree-nesting raptors are common in the Cook Inlet drainages study area (Figure 41.1-10).

Bald Eagle. Bald Eagles are common to the forests, anadromous streams, and lakes of southwestern Alaska (Buehler, 2000). They typically nest in forested areas adjacent to large bodies of water but are widespread from coastal to alpine habitats when foraging and migrating. They nest in trees but will also nest on cliffs or the ground, especially in coastal areas when trees are absent (Buehler, 2000).

Suitable nesting habitat for Bald Eagles in the Cook Inlet drainages study area is uncommon and occurs in forests along the coast and near streams (e.g., Upland and Lowland Spruce Forest and Upland and Lowland Moist Mixed Forest) (Appendix 41.1D). One freshwater habitat (Rivers and Streams [Anadromous]) was considered to be of high value for foraging. Moderate-value habitats include Rivers and Streams, Lake and Ponds, and Lowland Sedge–Forb Marsh. Low-value habitats include most alpine and upland areas, and scrub, scrub-bog, and meadow habitats in lowland and riverine settings; Bald Eagles range widely, however, and they will use most of these open habitats at least infrequently. Use of the abundant tall-scrub habitats in the study area probably is negligible. Several marine habitats were considered to be of moderate value for foraging by Bald Eagles, including estuarine areas, mud and sand flats, cliffs, and subtidal waters (Appendix 41.1E). All other marine habitats in the study area were considered to be of low or negligible value.

Northern Goshawk. Goshawks nest in most forest types within their range and use a diverse set of habitats for foraging, ranging from open steppes to dense forest, including riparian areas (Squires and Reynolds, 1997). The southwestern extent of the breeding range of Northern Goshawks in Alaska includes woodlands in Iliamna Lake area (Squires and Reynolds, 1997). However, given the paucity of forest habitats in this coastal area, the Northern Goshawk likely is uncommon in Cook Inlet drainages study area.

Northern Goshawks prefer to nest in large trees in forests with high canopy closure and sparse ground cover, near the bottom of slopes (Squires and Reynolds, 1997). Probably only two habitats (Upland and Lowland Spruce Forest and Upland and Lowland Moist Mixed Forest) meet these qualifications in the Cook Inlet drainages study area. However, they forage in a larger suite of habitats within and adjacent to these forested habitats, so there would be at least low-value terrestrial habitats in lowland and open upland settings in the Cook Inlet Study Area (Appendix 41.1D). Northern goshwaks rarely, if ever, occur in marine habitats, and marine habitat values were not assessed for this species.

Merlin. Merlins breed throughout the arctic, alpine and boreal areas of Alaska in open to semi-open habitats, migrating to more temperate zones in winter (Warkentin et al., 2005). They do not build nests, but typically occupy old corvid, hawk or magpie nests; infrequently they nest in tree cavities and on the ground. Merlins tend to use nests located near forest openings, in woodlots and near rivers, lakes or bogs, as they prefer to forage in these open areas.

Merlins may nest along slopes with willow and alder scrub and within Upland and Lowland Spruce Forest, and Upland and Lowland Moist Mixed Forest in the Cook Inlet drainages study area. They also probably range widely through the study area while foraging during breeding and migration. Moderate-value terrestrial and freshwater habitats would include Rivers and Streams (Anadromous), Lakes and Ponds, and any of the forested habitats in the study area (Appendix 41.1D). Three marine habitats (Protected Mud Flat, Protected Sand Flat, and Shallow Subtidal Waters) were considered to be of moderate value for foraging by Merlins (Appendix 41.1E). All other marine habitats in the study area were considered to be of low or negligible value.

Great Horned Owl. Woodlands in the lower Cook Inlet area are within the southwestern extent of the range of Great Horned Owls in Alaska (Houston et al., 1998). Nest sites are extremely variable and Great Horned Owls commonly use stick nests made by other birds (e.g., hawks, ravens), but also will nest in tree cavities, cliffs, and occasionally on the ground (Houston et al., 1998). They are resident throughout their range, but may wander extensively outside the breeding season. They are opportunistic predators with one of the widest prey bases of all owls, preying on small- and medium-sized mammals, hares, and birds (including ducks, geese, grouse, and loons). In northern regions during the winter, snowshoe hares may be especially important prey for owls due to the scarcity of other overwintering birds and mammals (Houston et al., 1998).

Moderate-value breeding habitat for Great Horned Owls in the Cook Inlet drainages study area probably is limited to the two upland and lowland forest types. They also forage in habitats closely associated with forests (e.g., meadows and tall- and low-scrub habitats in riverine settings), and these habitats were considered to be of moderate value; most other habitats in the study area probably are of low to negligible value for Great Horned Owls (Appendix 41.1D). Great Horned Owls rarely, if ever, occur in marine habitats, and marine habitat values were not assessed for this species.

Cliff-nesting Raptors

The suitability of habitats (moderate or high habitat-value rankings) for both nesting and foraging cliff-nesting raptors in the Cook Inlet drainages study area was assessed spatially in map form (Figure 41.1-11). This figure displays the overall habitat availability for the three cliff-nesting raptors species of concern addressed in this study. Habitat values were assessed for all three species in terrestrial and freshwater habitats and for two of the three species in marine habitats (one species only occasionally uses marine habitats).

Three relatively open upland habitats (Upland Dry Dwarf Shrub–Lichen Scrub, Upland Moist Dwarf Scrub, and Upland Moist Low Willow Scrub) were considered suitable for two of the three cliff-nesting raptor species for foraging, and one aquatic habitat (Rivers and Streams) was considered suitable for two of the three species for nesting (nesting only when cliffs are present) (Appendix 41.1D). These habitats, however, are uncommon in the study area. Other alpine, upland, forest, scrub, scrub-bog, meadow, marsh, and lacustrine and riverine aquatic habitats were considered suitable for one of the three species for foraging and/or nesting (nesting only when cliffs are present). Terrestrial and lacustrine habitats suitable for cliff-nesting raptors are uncommon in the study area and riverine habitats also are uncommon.

Overall, terrestrial and freshwater habitats considered suitable for nesting and foraging by cliff-nesting raptors in the Cook Inlet drainages study area are uncommon (Figure 41.1-11).

One marine habitat (Supratidal Cliff) was considered suitable for foraging and possible nesting by both of the cliff-nesting raptor species assessed for marine habitat values (Appendix 41.1E). Other marine habitats considered suitable for foraging or possible nesting by one of the two cliff-nesting raptor species assessed included cliffs, estuarine areas, mud and sand flats, and subtidal waters. Overall, suitable marine habitats for foraging and nesting by cliff-nesting raptors are common in the Cook Inlet drainages study area (Figure 41.1-11).

Golden Eagle. Golden Eagles inhabit open coniferous forest, tundra, and barren habitats in Alaska, and are known to occur in the Iliamna Lake area (Kochert et al., 2002). They occasionally nest in the Cook Inlet drainages study area, nesting primarily on cliffs in upland and riparian areas. Golden Eagles also will nest in trees, riverbanks, on the ground, or on human-made structures (Kochert et al., 2002). Foraging habitats during the breeding and migration seasons include a variety of open lowland and upland habitats.

Golden Eagles probably range widely throughout the upland and alpine regions in the Cook Inlet drainages study area, feeding primarily on ground squirrels, hares, marmots, and ptarmigan, but also feeding on seabirds, waterfowl, and carrion. High-value habitats for nesting include cliff areas, primarily in Alpine Dry Barrens. Moderate-value nesting habitat occurs in cliff areas along Rivers and Streams. Moderate-value terrestrial habitats for foraging include all the dwarf- and low-scrub types in alpine and upland areas (Appendix 41.1D). One marine habitat (Supratidal Cliff) was considered to be of moderate value for possible nesting by Golden Eagles; all other marine habitats in the study area were categorized as low or negligible value (Appendix 41.1E).

Gyrfalcon. Gyrfalcons nest in tundra habitats throughout Alaska (Clum and Cade, 1994), but probably are rare breeding birds in the Cook Inlet drainages study area (see Section 41.3). Gyrfalcons generally are non-migratory but will move, especially if winter prey are limited (Cade, 1960). Foraging habitats during all seasons include the majority of upland and alpine habitats found in the study area.

Although no nesting pairs or signs of Gyrfalcon use were detected in the Cook Inlet drainages study area (see Section 41.3), some cliff areas may have potential for nesting. Because of their scarcity, most terrestrial habitats probably are of low to negligible value for this species in the study area (Appendix 41.1D). Gyrfalcons only occasionally use marine habitats for foraging, and marine habitat values were not assessed for this species.

Peregrine Falcon. Peregrine Falcons nest on ledges and in stick nests built by other raptors and corvids along riverine and marine habitats in Alaska (Cade, 1960). They are much less common on lacustrine cliffs, off-river cliffs, and artificial platforms. One nest was located near the Cook Inlet drainages study area (see Section 41.3), but suitable cliff habitat occurs along much of the coast, and migrating birds probably use the area more frequently.

Cliff areas particularly near the coast along Rivers and Streams and Rivers and Streams (Anadromous) are potential moderate-value nesting habitats. Rivers and Streams (both types) also are moderate-value habitats for foraging Peregrine Falcons in the Cook Inlet drainages study area. Other moderate-value terrestrial and freshwater habitats for foraging include dwarf- and low-scrub types in upland and riverine areas, forests, scrub-bog, meadow, and marsh habitats, and Lakes and Ponds (Appendix 41.1D). Cliff habitats in the marine environment were considered to be of high value for possible nesting by Peregrine Falcons, especially as the breeding population of this species increases. Moderate-value habitats for foraging include estuarine areas, mud and sand flats, and subtidal waters (Appendix 41.1E). All other marine habitats in the study area were considered to be of low value.

Waterbirds

The overall habitat availability in the Cook Inlet drainages study area for the 17 waterbird species of concern addressed in this study was assessed spatially in map form (Figure 41.1-12). This figure displays the suitability of habitats (moderate or high habitat-value rankings) for breeding and nonbreeding waterbirds considered as a group. Habitat values were assessed for three of the 17 species that were found to occur in terrestrial and freshwater habitats (see Section 41.4) and for 15 of the 17 species that were observed in marine habitats (see Chapter 44).

One freshwater habitat (Rivers and Streams [Anadromous]) was considered suitable for two of the three species assessed for terrestrial/freshwater habitat values (Appendix 41.1D). Suitable habitats for one of the three species assessed include riverine meadow and scrub habitats, and Lakes and Ponds. None of these riverine or lacustrine habitats, however, is common in the study area. Overall, suitable terrestrial and lacustrine habitats for breeding and nonbreeding waterbirds are not common in the Cook Inlet drainages study area (Figure 41.1-12). Freshwater stream habitats in the study area also are not common, which is typical for mountainous landscapes.

Three marine habitats (Protected Mud Flat, Protected Sand Flat, and Protected Gravel/Sand Beach) were considered suitable for 12 to 14 of the 15 waterbird species assessed for marine habitat values, primarily for foraging and loafing (Appendix 41.1E). Other marine habitats considered suitable for fewer species (8–10) of the 15 waterbird species assessed included Exposed Sand Flat; Exposed Gravel/Sand Beach; protected beaches in association with rocky ramps, platforms, and cliffs; and subtidal waters. Marine habitats used by the smallest number of species (2–4) of the 15 waterbird species assessed included Protected Estuary, Protected and Exposed Rocky Ramp-Platform, Protected and Exposed Rocky Cliff, and exposed beaches in association with rocky ramps, platforms, and cliffs. In addition to the use of these habitats for foraging and/or loafing by several different species, the rocky cliff habitats also could be used by some waterbirds (e.g., cormorants) for nesting. Overall, suitable marine habitats for nonbreeding waterbirds and a few breeding waterbird species are common in the Cook Inlet drainages study area (Figure 41.1-12).

Trumpeter Swan. For breeding, Trumpeter Swans prefer waterbodies with irregular shorelines, emergent vegetation, abundant and diverse communities of aquatic plants, early ice-off, a depth less than 1.2 meters, and multiple available nest sites (Mitchell and Eichholz, 2010). Trumpeter Swans build high nest-mounds near lake margins, on islands, or even on top of beaver dams, and return to the same breeding territory each year, sometimes reusing the same nest site (Mitchell and Eichholz, 2010). The Iliamna Lake area is on the western edge of the Trumpeters Swan's breeding distribution in Alaska (Conant et al., 2002).

In 2005, a Trumpeter Swan nest was found in a wetland area adjacent to Bowser Creek, near the Cook Inlet Drainages study area (see Section 41.4). The nest was located in a wetland habitat similar to that which occurs in the Y Valley. Lakes and Ponds was considered to be a moderate-value habitat for Trumpeter Swans because it provides potential nesting, brood-rearing, and foraging habitat (Appendix

41.1D); this habitat type, however, is uncommon in the Cook Inlet Drainages study area. Five other riverine and lowland habitats often in association with Lakes and Ponds provide potential breeding habitat and were considered to be of low value, primarily because they are patchy in occurrence and uncommon in the study area. Swans (unidentified to species) only rarely were observed in marine habitats in Iniskin and Iliamna bays (see Chapter 44); marine habitat values were not assessed for Trumpeter Swans.

Dabbling Ducks in Marine Habitats (American Wigeon, Mallard, Northern Pintail, Green-winged Teal). During spring and fall migration, dabbling ducks, including American Wigeon, Mallard, Northern Pintail, and Green-winged Teal, stage along the tidal flats of Cook Inlet (Bennett, 1996). During surveys in spring and fall migration in 2004 and 2005 in the Cook Inlet drainages study area, the peak abundance of dabbling ducks was found in late April to early May and late August to early September (see Section 41.4). Mallards were the most common dabbling ducks during both migration seasons and Northern Pintails the least common. Marine habitats that dabbling ducks use during migration include shallow brackish coastal waters, brackish tidal marshes, creeks, and estuarine areas (Palmer, 1976). In southeastern Alaskan tidal marshes, Mallards were found to feed both on animal food, especially caddisfly (*Trichoptera*) larvae, and plant food (mostly sedges) (Hughes and Young, 1982).

Within the Cook Inlet drainages study area, dabbling ducks were recorded primarily in Protected Mud Flat and secondarily in Protected Estuary, both considered to be high-value habitats (Appendix 41.1E). The highest density of dabbling ducks in these two habitat types in the study area occurred at the creek outlet at Williamsport. Mallards also were found using Protected Sand Flat and Protected Gravel/Sand Beach in Iliamna Bay, and both of these habitats were considered to be of moderate value for dabbling ducks. Green-winged Teal were found at two locations between North Head and Knoll Head using Protected and Exposed Rocky Cliff with Gravel/Sand Beach; these habitats, however, were considered to be of low value for dabbling ducks as a group.

Diving Ducks in Marine Habitats (Greater Scaup, Surf Scoter, Black Scoter, Long-tailed Duck). In the Cook Inlet drainages study area, Greater Scaup stage in large groups during spring and fall migration while Long-tailed Ducks and Surf and Black Scoters occur during all months in the non-breeding season (August through May); the highest counts for all these species occur during spring and fall migration (see Section 41.4 and Chapter 44). Greater Scaup occur in nearshore marine waters during migration where they feed on mollusks (Kessel et al., 2002). Both Surf and Black Scoters prefer shallow marine waters less than 10 meters deep occurring over sands, pebbles, gravels, and cobbles (Bordage and Savard, 1995; Savard et al., 1998). Scoters feed mostly on mollusks (mussels, clams) when staging, molting, or wintering in saltwater (Vermeer, 1981). Long-tailed Ducks prefer protected bays with steep slopes and shorelines with gradual shelves leading to sandy or cobble bottoms (Robertson and Savard, 2002). In marine waters, Long-tailed Ducks eat a variety of prey, but primarily feed on crustaceans (Robertson and Savard, 2002).

All four species of diving ducks were found using Shallow Subtidal Waters in the Cook Inlet drainages study area. Long-tailed Ducks and Surf and Black Scoters also were found in Deep Subtidal Waters within the study area, and Greater Scaup used this same habitat outside the study area boundaries. Both subtidal water habitats were considered to be of high value for all four species (Appendix 41.1E). In intertidal habitats within the study area or near there, Greater Scaup, Long-tailed Ducks, and Surf and Black Scoters were recorded commonly in Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat. These three habitats, along with Protected Gravel/Sand Beach, were considered to be high-value foraging habitats for the four species of diving ducks. Three other habitats, all with a beach component (Protected Rocky Ramp–Platform with Gravel/Sand Beach, Protected Rocky Cliff with Gravel/Sand Beach, and Exposed Gravel/Sand Beach) were considered to be moderate-value habitats for scoters and Long-tailed Ducks. Only one of these beach habitats (Exposed Gravel/Sand Beach) was considered to be of moderate value for Greater Scaup.

Steller's Eider. Nonbreeding Steller's Eiders occur in marine waters in the lower Cook Inlet area only during the winter months and, in Iniskin and Iliamna bays, they spend most of their time feeding and resting in offshore waters (see Chapter 44). In the surveys conducted from 2004 to 2008 (see Chapter 44), no observations were made in nearshore waters or intertidal habitats. However, during surveys in 2009, some relatively small flocks were observed on several occasions in nearshore waters in Iniskin and Iliamna bays. None of these observations occurred within the area mapped for marine habitats in the Cook Inlet drainages study area. However, because the species clearly uses nearshore habitats, at least on occasion, two habitats (Shallow and Deep Subtidal Waters) were considered to be of low value for Steller's Eiders in the Cook Inlet drainages study area. Outside the narrowly delimited study area for marine habitat mapping, other stretches of Deep Subtidal Waters in the broader Iniskin/Iliamna bay area likely are of high value to Steller's Eiders, based upon the observed use in those areas. Shallow Subtidal Waters likely are of low value throughout the Iniskin/Iliamna bay area.

Harlequin Duck. Harlequin Ducks spend the winter in marine habitats where they reunite with their mates before heading to breeding streams (Smith et al., 2000). In late April to late May, Harlequin Ducks leave winter marine habitats to nest along freshwater streams. Harlequin Ducks nest and rear their young along clear, fast-flowing streams with abundant aquatic food (midge larvae, caddisflies, stoneflies, mayflies, and crustaceans) in riparian, subalpine, or coastal habitats (Bengtson, 1966; Palmer, 1976; Robertson and Goudie, 1999). The surrounding vegetation can be closed forest, open forest, valleys with willow or alder, or tundra (Robertson and Goudie, 1999). Nests can be on the ground, on small cliff ledges, or in tree cavities or stumps low to the ground, but they are always near stream waters and commonly are built on islands (Bengtson, 1966; Robertson and Goudie, 1999). Harlequin Ducks return to the same breeding territory each year and sometimes reuse the same nest site (Robertson and Goudie, 1999). They are a common breeder along the rivers of the Alaska Peninsula, and broods were found in streams in the Y Valley near the Cook Inlet drainages study area (see Section 41.4).

Pre-nesting and brood-rearing Harlequin Ducks were found during field surveys in 2004 and 2005 in streams in the Y Valley near the Cook Inlet drainages study area. The mainstem stream draining the Y Valley is classified as Rivers and Streams (Anadromous) and was considered to be a high-value habitat for Harlequin Ducks because it is used for pair bonding and mating during pre-nesting, and for foraging during nesting and brood-rearing (Appendix 41.1D). Riverine Wet Graminoid–Shrub Meadow, Riverine Low Willow Scrub, and Riverine Tall Alder or Willow Scrub were considered to be high-value nesting habitats, especially when found on riverine islands and on the shorelines of Rivers and Streams (Anadromous). These three habitats also provide escape and resting habitat for Harlequin Ducks.

Harlequin Ducks return to marine habitats between July and October to molt (Robertson and Goudie, 1999). Males depart breeding streams for molting areas after females start incubating. Nonbreeding females and/or failed nesters depart for marine molting areas by the end of August, whereas females with young may arrive as late as October (Robertson et al., 1997). Fidelity to molting locations is very high (Breault and Savard, 1999). Harlequin Ducks may overwinter in the same areas that are used for molting

(Smith et al., 2000). In the marine environment, they use rocky or cobble nearshore habitats, feeding in the surf or loafing on rocks (Robertson and Goudie, 1999). Harlequin Ducks along the coastline of Lake Clark National Park and Preserve were concentrated on shoreline types described as wide and narrow sand and gravel flats (Bennet, 1996). In marine habitats, they feed on fish roe and invertebrates in intertidal and subtidal areas (Roberston and Goudie, 1999).

During the nonbreeding season, most Harlequin Ducks in the Cook Inlet drainages study area were found in Shallow and Deep Subtidal Waters, both of which were considered to be high-value habitats (Appendix 41.1E). Eleven other marine habitats were considered to be of high value for Harlequin Ducks for resting, loafing, and foraging. Harlequin Ducks occurred in seven of those 11 habitats within the study area. Harlequin Ducks forage and loaf in intertidal areas in Protected and Exposed Mud Flat, Sand Flat, and Gravel/Sand Beach. Protected and Exposed Rocky Ramp–Platform habitats (with and without Gravel/Sand Beach) provide resting habitat.

Red-throated Loon. Red-throated Loons are closely linked to coastal areas during both the breeding and nonbreeding seasons (AKNHP, 1999). During the breeding season, Red-throated Loons fly from nest lakes to nearshore marine waters to forage for fish for themselves and their young (Bergman and Derksen, 1977). During migration and in wintering areas, such as the coast of the Alaska Peninsula (Rizzolo and Schmutz, 2009), Red-throated Loons forage in nearshore waters. A change in the composition, distribution, and abundance of fish species in the Gulf of Alaska during the mid-1970s to 1980s is suspected to have affected the diet of Red-throated Loons feeding in that area and may be a factor in the declines observed in some Red-throated Loon populations (AKNHP, 1999).

Red-throated Loons were found to occur rarely in Iniskin and Iliamna bays (see Chapter 44). Only one observation, in Protected Mud Flat, occurred in the Cook Inlet drainages study area. Three intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Protected Gravel/SandBeach) and both Shallow and Deep Subtidal Waters were considered to be high-value foraging habitats for Red-throated Loons (Appendix 41.1E). Exposed Sand Flat, Exposed Gravel/Sand Beach, and Protected Rocky Ramp–Platform and Protected Rocky Cliff (both with beaches) were considered to be moderate-value habitats.

Horned Grebe. During migration and in winter, Horned Grebes reside in nearshore marine waters, including sheltered bays, lagoons, or estuaries (Stout and Cooke, 2003). Horned Grebes were observed in small numbers in Iniskin and Iliamna bays during spring 2006 (see Chapter 44). Horned Grebes typically forage in shallow to moderately deep waters (less than 6 meters) during migration and winter, and feed primarily on benthic invertebrate species (Stedman, 2000).

Horned Grebes were observed in six different habitat types during surveys in the Cook Inlet drainages study area. Habitats considered to be of high value for Horned Grebes are those preferred for foraging and loafing, and include Protected Mud Flat, Protected Sand Flat, Protected Gravel/Sand Beach, and Shallow and Deep Subtidal Waters (Appendix 41.1E). Exposed Sand Flat, Exposed Gravel/Sand Beach, and Protected Rocky Ramp–Platform and Protected Rocky Cliff (both with beaches) were considered to be moderate-value habitats.

Pelagic and Red-faced Cormorants. Pelagic Cormorants nest in colonies on cliff faces, ledges in coastal caves, and on man-made structures such as navigation lights, bridges, and pilings (Carter et al., 1984; Hobson and Wilson, 1985). Roost sites near foraging areas also are important for cormorants for drying their feathers (cormorants lack oil glands for waterproofing feathers; Hobson, 1997). Communal roosting sites include sand bars, exposed rocks, cliff faces, or caves (Hobson, 1997). In the Iniskin Bay area, groups of up to 80 cormorants have been observed roosting at sites on the Mushroom Islets, Vert Island, and Big Rock (see Chapter 44). Pelagic Cormorants often forage for fish in relatively shallow waters above rocky substrates within bays and fjords, in subtidal waters over sand and mud, and in deeper waters; they also forage in benthic habitats for invertebrates (Hobson, 1997). They feed their chicks fish and benthic invertebrates (Hobson, 1997). Red-faced Cormorants are uncommon in Iniskin and Iliamna bays (see Chapter 44) and use the same habitats as Pelagic Cormorants for nesting, foraging, and loafing/roosting; the two species often occur together in mixed flocks and appear to have similar food preferences (Causey, 2002).

Pelagic Cormorants were recorded in four different habitats in the Cook Inlet drainages study area. Most cormorants were found in Shallow Subtidal Waters, which probably is used primarily for foraging. Deep Subtidal Waters also likely are used for foraging. Both subtidal-water habitats in the study area were considered to be of high value for cormorants (Appendix 41.1E). Protected and Exposed Rocky Ramp–Platform and Rocky Cliff (with and without beaches) were considered to be high-value habitats for foraging, loafing, and roosting. Moderate-value habitats for cormorants included Protected and Exposed Gravel/Sand Beach and Rocky Cliff.

Arctic Tern. Arctic Terns breed throughout Alaska in tundra and open boreal forest habitats (Hatch, 2002) and they were considered an abundant breeder near large waterbodies in the Iliamna Lake region (Williamson and Peyton, 1962). Arctic Terns nest in a wide variety of open, usually treeless terrain, often with no vegetation or with low or scattered plant cover (Hatch, 2002). Generally they nest close to water, frequently on small rocky, gravelly, grassy, or peaty islands; also barrier beaches and sand or gravel spits, gravel bars in rivers, or glacial moraines, as well as marshes, bogs, and grassy meadows (Hatch, 2002).

Although Arctic Terns were not observed during spring and fall migration surveys in 2004 and 2005 in the Cook Inlet drainages region (see Section 41.4), potential foraging habitat occurs in the rivers of the Y Valley and in Williams Creek. Rivers and Streams (Anadromous) was considered to be of moderate value, and Rivers and Streams was considered to be of low value for Arctic Terns. Arctic Terns have not been observed in marine habitats in Iniskin and Iliamna bays (see Chapter 44), and marine habitat values were not assessed for this species.

Marbled Murrelet. Marbled Murrelets are considered year-round residents in marine waters in lower Cook Inlet although the numbers of birds are higher during summer than winter; in this area, the species is more often found in nearshore waters than offshore waters (Agler et al., 1995). Murrelets forage in the water column, most commonly in shallow, protected waters, and the diet of birds in Cook Inlet includes small schooling fish and invertebrates (Piatt et al., 2007).

In the Cook Inlet drainages study area, Marbled Murrelets were most commonly observed in Shallow and Deep Subtidal Waters, both considered to be high-value habitats (Appendix 41.1E). Other high-value habitats for this species, where they forage during high tide, include Protected Sand Flat, Protected and Exposed Rocky Ramp–Platform and Rocky Cliff (when they occur with beaches), and Protected Gravel/Sand Beach. Habitats considered to be of moderate value were Protected Mud Flat, Exposed Sand Flat, and Exposed Gravel/Sand Beach.

Shorebirds

The overall habitat availability in the Cook Inlet drainages study area for the 12 shorebird species of concern addressed in this study was assessed spatially in map form (Figure 41.1-13). This figure displays the suitability of habitats (moderate or high habitat-value rankings) for breeding and nonbreeding shorebirds considered as a group. Habitat values were assessed for seven of the 12 species that were observed or are likely to occur in terrestrial and freshwater habitats as breeders (see Section 41.5) and for all 12 species that were observed (see Chapter 44) or are likely to occur during migration or as overwintering birds in marine habitats.

One habitat (Alpine Moist Dwarf Scrub) was considered suitable for two of the seven potential breeding shorebird species assessed for terrestrial/freshwater habitat values (Appendix 41.1D). Three other open habitats (Alpine Dry Barrens, Upland Dry Dwarf Shrub–Lichen Scrub, and Upland Moist Dwarf Scrub) were considered suitable for one of the seven species assessed. These habitats, however, are not common and are widely scattered throughout the study area. Overall, suitable open terrestrial habitats for breeding shorebirds are not common in the Cook Inlet drainages study area (Figure 41.1-13).

Four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered suitable for eight to 11 of the 12 shorebird species assessed for marine habitat values (Appendix 41.1E). These four habitats are used by shorebirds that forage in soft-sediment habitats, primarily during spring and fall migration and/or during winter. Four other marine habitats (the protected and exposed forms of Rocky Ramp-Platform, both with and without Gravel/Sand Beach) were considered suitable for four of the 12 shorebird species assessed. These habitats are used by shorebird species that forage in rocky intertidal habitats during the breeding and/or non breeding seasons. Another four habitats (the protected and exposed forms of Gravel/Sand Beach, and the protected and exposed forms of Rocky Cliff with Gravel/Sand Beach) were considered suitable for one of the 12 shorebird species assessed. In addition to the use of these habitats for foraging and roosting by several different species, the rocky ramp and gravel/sand beach habitats also could be used by Black Oystercatchers for nesting (see below). Overall, suitable marine intertidal habitats for nonbreeding shorebirds and for one breeding species are common in the Cook Inlet drainages study area (Figure 41.1-13).

American Golden-Plover. Breeding American Golden-Plovers in Alaska occur in open arctic, subarctic, alpine, and upland tundra habitats (Johnson and Connors, 1996; ASG, 2008). In the state, they breed as far south as southwestern Alaska, including the northern portions of the Alaska Peninsula, where they use open upland and alpine habitats. Typically a substantial cover of lichens on rocks or soil is present in nesting areas, which aids in making the eggs more cryptic on the open tundra. Brood-rearing occurs in open tundra and in adjacent open wetland habitats. During migration, American Golden-Plovers use open and well-drained inland habitats as well as freshwater wetlands and marine intertidal habitats (Johnson and Connors, 1996). In marine areas in Cook Inlet, they are uncommon migrants, often foraging in soft-sediment intertidal habitats; most birds occur in the area during spring migration (Gill and Tibbitts, 1999; ABR, 2007). American Golden-Plovers occur seasonally in Alaska and migrate to tropical regions for the winter.

Montane tundra habitats suitable for breeding American Golden-Plovers are uncommon in the Cook Inlet drainages study area. These habitats were not adequately sampled (less than 10 point-counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the species was not observed in the study area but has the potential to occur there, Alpine Moist Dwarf Scrub, Upland Moist Dwarf Scrub, and Upland Dry Dwarf Shrub–Lichen Scrub were considered to be of moderate value for American Golden-Plovers (Appendix 41.1D). All other terrestrial and freshwater habitats were categorized as low or negligible value.

American Golden-Plovers were not observed during surveys for marine birds and mammals in Iniskin and Iliamna bays (see Chapter 44). Intertidal mud and sand flat habitats, however, are present in the area, so there is some potential for the species to occur in the Cook Inlet drainages study area. Because of this, four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value for American Golden-Plovers (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Black Oystercatcher. Black Oystercatchers occur year-round in south-coastal Alaska and the Aleutian Islands, and the lower Cook Inlet and Bristol Bay areas represent the northern extent of their range in the state. In all months of the year, they rely heavily on rocky intertidal habitats and are almost never found outside of coastal areas (Andres and Falxa, 1995). They prefer to nest on sparsely vegetated islands, where they use both gravelly beaches and rocky habitats; intertidal flats are used rarely during breeding. Foraging is concentrated on low, sloping rocky ramps and level rocky platforms, but in winter in Alaska, tidal flats also can be used, especially when mussel (*Mytilus edulis*) beds are present.

Black Oystercatchers were observed in most months of the year during surveys in the Iniskin/Iliamna bay area (see Chapter 44). In the Cook Inlet drainages study area, they were observed primarily in rocky intertidal and gravelly beach habitats. Eight marine habitats (the protected and exposed forms of Rocky Ramp–Platform, both with and without Gravel/Sand Beach; the protected and exposed forms of Rocky Cliff with Gravel/Sand Beach; and the protected and exposed forms of Gravel/Sand Beach) were considered to be of high value for Black Oystercatchers in the study area (Appendix 41.1E). Three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value. All other marine habitats were categorized as low or negligible value.

Solitary Sandpiper. A bird of the boreal forest region, the Solitary Sandpiper breeds near lakes and ponds in forest openings, often coniferous forests, and near lacustrine waterbodies in dwarf-spruce woodlands, scrub bogs, and tall-scrub thickets (Moskoff, 1995; ASG, 2008). In migration, Solitary Sandpipers primarily occur along the margins of freshwater ponds and lakes and are rare in the marine environment (Moskoff, 1995). During surveys in the Cook Inlet area, they were recorded only rarely in migration using intertidal mud and sand flat habitats (Gill and Tibbitts, 1999; ABR, 2007). Solitary Sandpipers occur seasonally in Alaska and migrate to subtropical and tropical regions for the winter.

Forest openings and bog habitats with lakes and ponds suitable for breeding Solitary Sandpipers are uncommon in the Cook Inlet drainages study area. Many of these habitats were not adequately sampled (less than 10 point-counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the quality of the available habitats was considered low for this species (mountainous terrain dominated by tall alder-scrub in which wetland patches are few and small) and because the species was not observed in the study area, but has the potential to occur there, all mapped terrestrial and freshwater habitats were considered to be of low or negligible value for Solitary Sandpipers (Appendix 41.1D).

Similarly, because Solitary Sandpipers occur rarely in marine habitats and were not recorded during surveys in Iniskin and Iliamna bays (see Chapter 44), all marine habitats in the Cook Inlet drainages study area were considered to be of low or negligible value (Appendix 41.1E).

Lesser Yellowlegs. Lesser Yellowlegs is a common breeder in boreal forest openings and in forest/tundra transition areas, but often is less common in adjacent subarctic tundra habitats (Tibbitts and Moskoff, 1999; ASG, 2008). Complexes of open forest and scrub, wet sedge meadows, bogs, marshes, and ponds are typically used as nesting areas. Brood-rearing occurs along lake and pond margins, often with emergent vegetation and a border of concealing vegetation. During migration, Lesser Yellowlegs use wetland habitats in both freshwater and marine environments; they prefer areas with shallow ponds or pools, often with emergent vegetation, but will use intertidal flats also, especially when tidal pools are present (Tibbitts and Moskoff, 1999). In the Cook Inlet area, Lesser Yellowlegs forage in soft-sediment intertidal habitats and primarily occur during spring and uncommonly in fall migration (Gill and Tibbitts, 1999; ABR, 2007). Near areas where they breed, they also forage during the summer months on intertidal flats, especially in upper Cook Inlet (Gill and Tibbitts, 1999). Lesser Yellowlegs occur seasonally in Alaska and migrate to temperate and tropical regions for the winter.

Suitable forest, scrub, and wetland habitats for breeding Lesser Yellowlegs are uncommon in the Cook Inlet drainages study area. Many of these habitats were not adequately sampled (less than 10 point-counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the quality of the available habitats was considered low for this species (mountainous terrain dominated by tall alder-scrub in which wetland patches are few and small) and because the species was not observed in the study area, but has the potential to occur there, all mapped terrestrial and freshwater habitats were considered to be of low or negligible value for Lesser Yellowlegs (Appendix 41.1D).

Lesser Yellowlegs were not observed during surveys for marine birds and mammals in Iniskin and Iliamna bays (see Chapter 44). Intertidal mud and sand flat habitats, however, are present in the area, so there is some potential for the species to occur in the Cook Inlet drainages study area. Because of this, four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value for Lesser Yellowlegs (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Whimbrel. Across their range, Whimbrels breed in subarctic and alpine tundra and taiga habitats (Skeel and Mallory, 1996; ASG, 2008). Breeding can occur in well-drained, upland dwarf-scrub habitats, but in Alaska, breeding more commonly occurs in poorly drained, graminoid-dominated wetlands, often with hummocks of dwarf and/or low scrub (ASG, 2008; see also Chapter 16.5). During migration, Whimbrels use open meadow and dwarf-scrub habitats in inland and coastal areas as well as marine intertidal habitats (Skeel and Mallory, 1996). In the Cook Inlet area, Whimbrels were recorded commonly in soft-sediment intertidal habitats during spring and fall migration (Gill and Tibbitts, 1999; ABR, 2007), and some birds also were recorded during the summer months, possibly nonbreeders or failed breeders (Gill and Tibbitts, 1999). Whimbrels occur seasonally in Alaska and migrate to temperate and tropical regions for the winter.

Alpine tundra and wetland habitats suitable for breeding Whimbrels are uncommon in the Cook Inlet drainages study area. Many of these habitats were not adequately sampled (less than 10 point counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see

Section 41.5). Because the quality of the available habitats was considered low for this species (mountainous terrain dominated by tall alder-scrub in which wetland patches are few and small) and because the species was not observed in the study area, but has the potential to occur there, all mapped terrestrial and freshwater habitats were considered to be of low or negligible value for Whimbrels (Appendix 41.1D).

Whimbrels were not observed during surveys for marine birds and mammals in Iniskin and Iliamna bays (see Chapter 44). Intertidal mud and sand flat habitats, however, are present in the area, so there is some potential for the species to occur in the Cook Inlet drainages study area. Because of this, four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value for Whimbrels (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Hudsonian Godwit. In Alaska, Hudsonian Godwits have been found to breed in areas where open wet sedge meadow and bog habitats are intermixed with shallow ponds, drier upland areas, and forests, especially spruce forests (Elphick and Klima, 2002; ASG, 2008). In western Alaska, breeding also can occasionally occur far from forested areas in open wetland habitats, often with a scrub component. During migration, Hudsonian Godwits are found in a diverse array of inland and coastal wetland habitats, often with standing water (e.g., marshes, lake and pond margins, flooded fields), although beaches and mud flats and occasionally upland sites also are used (Elphick and Klima, 2002). In marine areas in Cook Inlet, they are common migrants during spring and fall, often foraging in soft-sediment intertidal habitats (Gill and Tibbitts, 1999; ABR, 2007). Like Lesser Yellowlegs, in the summer they also forage on intertidal flats near breeding areas, especially in upper Cook Inlet (Gill and Tibbitts, 1999). Hudsonian Godwits occur seasonally in Alaska and migrate to tropical regions for the winter.

Complexes of forest and wetland habitats suitable for breeding Hudsonian Godwits are not common in the Cook Inlet drainages study area. Many of these habitats were not adequately sampled (less than 10 point counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the quality of the available habitats was considered low for this species (mountainous terrain dominated by tall alder-scrub in which wetland patches are few and small) and because the species was not observed in the study area, but has the potential to occur there, all mapped terrestrial and freshwater habitats were considered to be of low or negligible value for Hudsonian Godwits (Appendix 41.1D).

Hudsonian Godwits were not observed during surveys for marine birds and mammals in Iniskin and Iliamna bays (see Chapter 44). Intertidal mud and sand flat habitats, however, are present in the area, so there is some potential for the species to occur in the Cook Inlet drainages study area. Because of this, four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value for Hudsonian Godwits (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Marbled Godwit. Most Marbled Godwits breed in interior grasslands in the northern U.S. and southern Canada, but a small and disjunct population of Marbled Godwits (probably less than 3,000 birds; ASG, 2008) breeds in Alaska between Ugashik Bay and Port Heiden on the Bering Sea coast of the Alaska Peninsula (Gibson and Kessel, 1989; Gratto-Trevor, 2000). The Alaskan birds are considered a separate subspecies (*L. f. beringiae*) (Gibson and Kessel, 1989). In the Cook Inlet area, only small numbers of Marbled Godwits occur as migrants, with most birds moving through during spring migration (Gill and

Tibbitts, 1999; see also Chapter 44). When they occur in coastal areas during migration and over the winter, Marbled Godwits routinely use soft-sediment intertidal habitats, including mud and sand flats and sandy beaches in lagoons and estuarine areas; during high-tide periods they often roost in supratidal saltmarsh habitats (Gratto-Trevor, 2000). Marbled Godwits occur seasonally in Alaska and migrate to coastal habitats in temperate and tropical regions for the winter.

Marbled Godwits were observed in small numbers during spring migration using soft-sediment intertidal habitats in upper Iniskin bay (see Chapter 44), but were not recorded in the Cook Inlet drainages study area. Because of their use of mud and sand flat and saltmarsh habitats in migration, four marine habitats (Protected Mud Flat, Protected Sand Flat, Exposed Sand Flat, and Protected Estuary) were considered to be of high value for Marbled Godwits in the study area (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Black Turnstone. Black Turnstones breed only in Alaska, most commonly in a narrow stretch of coastal habitats in western Alaska from Point Hope to the Alaska Peninsula, but occasionally further inland along gravelly shorelines of streams and lakes; most breeding occurs on the Yukon-Kuskokwim delta (Handel and Gill, 1992). During migration and over the winter, except for some post-breeding movements to gravelly stream and lake shorelines in southern Alaska, Black Turnstones are found almost exclusively in coastal habitats (Handel and Gill, 2001). Rocky intertidal habitats are commonly used, but mud and sand flats, saltmarshes, sandy beaches (along rocky coasts), and human-created habitats also are used. In the Cook Inlet area, Black Turnstones have been recorded in both rocky and soft-sediment intertidal habitats, but only during spring migration (Gill and Tibbitts, 1999; see also Chapter 44). Black Turnstones winter along the Pacific coast of North America in outer coastal regions in southern Alaska (as far west as Kodiak Island) south to northern Mexico. They only occur seasonally, however, in the Cook Inlet area.

Black Turnstones were regularly observed in small numbers during spring migration in the Iniskin/Iliamna bay area, primarily in rocky intertidal habitats; they were recorded once on intertidal mud flats in upper Iliamna Bay (see Chapter 44), just north of the Cook Inlet drainages study area. Four rocky intertidal habitats (the protected and exposed forms of Rocky Ramp– Platform, with and without gravel/sand beaches) were considered to be of high value for Black Turnstones in the study area (Appendix 41.1E). Three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) and one largely supratidal habitat (Protected Estuary) were considered to be of moderate value. All other marine habitats were categorized as low or negligible value.

Surfbird. Surfbirds breed exclusively in dry alpine areas characterized by barren rocky ground (often scree and rock fields) and scattered vegetation, typically dominated by dwarf shrubs and lichens, and occasionally moss (Senner and McCaffery, 1997; ASG, 2008). During migration, Surfbirds are typically found on exposed rocky coastlines, often in the spray zone just above the tide, and on protected rocky shores; they also can occur on sandy pocket beaches along rocky shorelines and on intertidal mud flats (Senner and McCaffery, 1997). In the Cook Inlet area, Surfbirds have been recorded in both rocky and soft-sediment intertidal habitats, but only during spring migration (Gill and Tibbitts, 1999; ABR, 2007; see also Chapter 44). Surfbirds winter in some ice-free regions of south-coastal Alaska (Kodiak Island, Prince William Sound, and southeastern Alaska) and along the Pacific coasts of North, Central, and South America. They only occur seasonally, however, in the Cook Inlet area.

Rocky alpine habitats suitable for breeding Surfbirds are uncommon in the Cook Inlet drainages study area. These habitats were not sampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the species was not observed in the study area but has the potential to occur there, Alpine Dry Barrens and Alpine Moist Dwarf Scrub were considered to be of moderate value for Surfbirds (Appendix 41.1D). All other terrestrial and freshwater habitats were categorized as negligible value for Surfbirds.

Surfbirds were observed in small numbers during spring migration in the Iniskin/Iliamna bay area, and only in rocky intertidal habitats (see Chapter 44). The species was not recorded in the Cook Inlet drainages study area. Four rocky intertidal habitats (the protected and exposed forms of Rocky Ramp–Platform, with and without gravel/sand beaches) were considered to be of high value for Surfbirds in the study area (Appendix 41.1E). Because of their observed use of mud and sand flat habitats in migration in other areas of Cook Inlet, three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value. All other marine habitats were categorized as low or negligible value.

Rock Sandpiper. Rock Sandpipers occur in the Cook Inlet area only during migration and winter. Primarily, it is the nominate subspecies (*C. p. ptilocnemis*) that occurs in Cook Inlet and virtually the entire population of this subspecies winters in the area, mostly in upper Cook Inlet (Gill and Tibbitts, 1999). This subspecies nests only on Bering Sea islands. In Cook Inlet, Rock Sandpipers are uncommon migrants, with most birds occurring during fall migration (Gill and Tibbitts, 1999). The Cook Inlet area is most important for this species during the winter, however, when the largest numbers occur. Migrant and wintering Rock Sandpipers often occur in rocky intertidal habitats, but in the upper Cook Inlet area, they forage largely on mud and sand flats (Gill and Tibbitts, 1999; ABR, 2007). In the winter, they are restricted primarily to foraging on intertidal flats that are not subjected to freezing spray and ice scour, as are rocky intertidal habitats in Cook Inlet (Gill et al., 2002).

In surveys in the Iniskin/Iliamna bay area, Rock Sandpipers were regularly observed during the winter months and uncommonly during spring and fall migration (see Chapter 44). They occurred in both rocky and soft-sediment intertidal habitats, but in Cook Inlet drainages study area, they were observed only in soft-sediment intertidal habitats. Three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) and four rocky intertidal habitats (the protected and exposed forms of Rocky Ramp–Platform, with and without gravel/sand beaches) were considered to be of high value for Rock Sandpipers in the study area (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Dunlin. In Alaska, Dunlin breed in arctic tundra habitats on the North Slope and in western coastal tundra regions of the state south to the northern coast of the Alaska Peninsula (Warnock and Gill, 1996). In the Cook Inlet area, Dunlin occur primarily as migrants during spring and fall, with far more birds occurring during the spring migration (Gill and Tibbitts, 1999; ABR, 2007). During migration and over the winter, Dunlin most often occur in soft-sediment intertidal habitats, although wetland habitats in inland areas and agricultural lands also can be used (Warnock and Gill, 1996). In Cook Inlet, they are common migrants, often foraging in intertidal mud and sand flat habitats (Gill and Tibbitts, 1999; ABR 2007). Dunlin winter in small numbers in south-coastal Alaska (Kodiak Island, eastern Cook Inlet to Prince William Sound, and in southeastern Alaska) and more commonly along the Pacific and Atlantic coasts of North America and northern Mexico. In western Cook Inlet, they only occur seasonally as migrants.

Dunlin were observed commonly during spring migration using soft-sediment intertidal habitats in the Iniskin/Iliamna bay area (see Chapter 44). They also were recorded in small numbers in mud and sand flat habitats in the Cook Inlet drainages study area. Four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of high value for Dunlin in the study area (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Short-billed Dowitcher. In Alaska, Short-billed Dowitchers breed in bog and open wet meadow habitats, often near the coast or in the floodplains of large rivers and streams (Jehl et al., 2001; ASG, 2008). Wetland meadow areas intermixed with open scrub, woodlands or open dwarf forests (e.g., wet black spruce forests) often are used for nesting. During migration, Short-billed Dowitchers feed most often in soft-sediment marine intertidal habitats including tidal flats and beaches, and occasionally in flooded inland habitats (agricultural fields and sewage ponds); like many shorebird species that feed on tidal flats, they roost in saltmarsh habitats at high tide (Jehl et al., 2001). Short-billed Dowitchers are a common migrant shorebird species in the Cook Inlet area during spring and fall, where they forage primarily in soft-sediment intertidal habitats (Gill and Tibbitts, 1999). Like Lesser Yellowlegs and Hudsonian Godwits, in the summer they also forage on intertidal flats near breeding areas, especially in upper Cook Inlet (Gill and Tibbitts, 1999). Short-billed Dowitchers occur seasonally in Alaska and migrate to temperate and tropical regions for the winter.

Woodland bog habitats suitable for breeding Short-billed Dowitchers are not common in the Cook Inlet drainages study area. Many of these habitats were not adequately sampled (less than 10 point counts) or unsampled during the point-count surveys in 2005, and the species was recorded only once in the area, as an incidental sighting (see Section 41.5). Because the quality of the available habitats was considered low for this species (mountainous terrain dominated by tall alder-scrub in which wetland patches are few and small) and because the species was rarely observed in the study area, all mapped terrestrial and freshwater habitats were considered to be of low or negligible value for Short-billed Dowitchers (Appendix 41.1D).

Short-billed Dowitchers were not recorded during surveys for marine birds and mammals in Iniskin and Iliamna bays, although a few unidentified dowitchers observed during spring migration may have been this species (see Chapter 44). Intertidal mud and sand flat habitats are present in the area, so clearly there is potential for the species to occur at least periodically in the Cook Inlet drainages study area. Because of this, four marine habitats (Protected Estuary, Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) were considered to be of moderate value for Short-billed Dowitchers (Appendix 41.1E). All other marine habitats were categorized as low or negligible value.

Landbirds

The overall habitat availability in the Cook Inlet drainages study area for the nine landbird species of concern addressed in this study was assessed spatially in map form (Figure 41.1-14). This figure displays the suitability of the mapped terrestrial and freshwater habitats (moderate or high habitat-value rankings) for breeding landbirds considered as a group. Habitat values for the marine habitats in the study area were not assessed for these nine landbird species because they do not occur in marine habitats.

Four tall-scrub and forest habitats (Upland Moist Tall Alder Scrub, Upland Moist Tall Willow Scrub, Upland and Lowland Moist Mixed Forest, and Upland and Lowland Spruce Forest) provide suitable breeding habitat for the greatest number (three) of the nine landbird species assessed (Appendix 41.1D). The alder-scrub habitats are abundant and are distributed throughout the study area, comprising 80 percent of the mapped habitats. The willow-scrub habitats are uncommon and widely scattered in the study area. The forest habitats also are uncommon and are concentrated largely in the Knoll Head area.

Three scrub habitats (Alpine Moist Dwarf Scrub, Upland Moist Low Willow Scrub, and Riverine Tall Alder or Willow Scrub) were considered suitable for two of the nine landbird species assessed, and another three habitats (Alpine Dry Barrens, Upland Moist Dwarf Scrub, and Riverine Low Willow Scrub) were considered suitable for one species. These six scrub and barren habitats are not common and are widely scattered throughout the study area. Overall, suitable terrestrial habitats for three of the nine species of breeding landbirds assessed are common and widespread in the Cook Inlet drainages study area (Figure 41.1-14); suitable habitats for four other species are uncommon, and no suitable habitats exist for two species (Appendix 41.1D and see below).

Spruce Grouse. Spruce Grouse are found exclusively in forested habitats. During breeding, they only occur in forests where conifer trees are dominant or co-dominant (Boag and Schroeder, 1992). Spruce Grouse are resident in Alaska, and during the nonbreeding seasons they can sometimes be found in deciduous forests.

Forested habitats suitable for Spruce Grouse are uncommon in the Cook Inlet drainages study area. These habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the species was not observed in the study area but has the potential to occur there, Upland and Lowland Spruce Forest and Upland and Lowland Moist Mixed Forest were considered to be of moderate value for Spruce Grouse (Appendix 41.1D). All other mapped habitats were categorized as negligible value.

Willow Ptarmigan. In Alaska, breeding Willow Ptarmigan commonly occur in low and tall scrub habitats, primarily in arctic, subarctic, and subalpine areas; they also use meadows and open tundra habitats, especially when there is a dwarf-shrub or low-shrub component (Kessel, 1989; Hannon et al., 1998). Willow Ptarmigan are resident in Alaska, and during the nonbreeding seasons, they tend to use areas with a greater vegetative cover of shrubs than during the summer months; they sometimes are found at lower elevations during the winter (Hannon et al., 1998).

Suitable alpine and upland habitats for Willow Ptarmigan are uncommon in the Cook Inlet drainages study area. These habitats were not adequately sampled (less than 10 point-counts) or unsampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the species was not observed in the study area but has the potential to occur there, the alpine and upland forms of moist dwarf scrub, and all the upland low- and tall-scrub habitats were considered to be of moderate value for Willow Ptarmigan (Appendix 41.1D). All other mapped habitats were categorized as low or negligible value.

Rock Ptarmigan. Throughout their range, Rock Ptarmigan breed in arctic and alpine tundra habitats; in alpine areas, they are typically found in areas with abundant, barren, rocky ground and sparse vegetation, often characterized by patches of dwarf shrubs (Montgomerie and Holder, 2008). During the nonbreeding seasons, they often are found in these same habitats.

Dwarf scrub and alpine barrens habitats suitable for Rock Ptarmigan are uncommon in the Cook Inlet drainages study area. These habitats were not sampled during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the species was not observed in the study area but has the potential to occur there, Alpine Dry Barrens and Alpine Moist Dwarf Scrub were considered to be of moderate value for Rock Ptarmigan (Appendix 41.1D). All other mapped habitats were categorized as low or negligible value.

Black-backed Woodpecker. Throughout their range, Black-backed Woodpeckers are found exclusively in forested habitats, especially coniferous forests or mixed forests with a strong coniferous tree component; in Alaska, the species is notably more abundant in areas with dead or dying trees and often selects smaller diameter, dead trees (coniferous or deciduous) for its nest sites (BPIFWG, 1999; Dixon and Saab, 2000). Black-backed Woodpeckers are resident in Alaska, and during the nonbreeding seasons they are found in the same habitats that are used during breeding.

Forested habitats suitable for Black-backed Woodpeckers are uncommon in the Cook Inlet drainages study area. These habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the quality of the available habitats was considered low for this species and the species was not observed in the study area, but has the potential to occur there, all mapped habitats were considered to be of low or negligible value for Black-backed Woodpeckers (Appendix 41.1D).

Olive-sided Flycatcher. Olive-sided Flycatchers breed primarily in montane and northern coniferous and mixed forests (BPIFWG, 1999; Altman and Sallabanks, 2000). They are more commonly found in open forests and make heavy use of forest openings (e.g., streams, ponds, lakeshores, bogs, meadows, burns, and other disturbances), where high perches along the forest edge are used for foraging and singing. Without forest openings, uneven canopies are preferred, which provide prominent perches above the canopy below. Wetter sites often are selected for their greater insect productivity.

Open-forest habitats suitable for Olive-sided Flycatchers are uncommon in the Cook Inlet drainages study area, and the species was recorded rarely in the area during the point-count surveys in 2005 (see Section 41.5). Forest habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys, but two habitats (Upland and Lowland Spruce Forest and Upland and Lowland Moist Mixed Forest) were considered to be of moderate value for Olive-sided Flycatchers (Appendix 41.1D). All other mapped habitats were categorized as low or negligible value.

Gray-cheeked Thrush. Gray-cheeked Thrushes in Alaska breed in dense tall-scrub habitats, often willow or alder, with a thick understory of low or dwarf shrubs (Kessel, 1998; BPIFWG, 1999; Lowther et al., 2001). Low-scrub habitats without an overstory of tall shrubs are less used than tall scrub. Gray-cheeked Thrushes are variable in their habitat use, however, and can occur in spruce forests near treeline, riverine tall-scrub habitats, open deciduous riverine forests, deciduous woodlands, scrub bogs, alder patches in tundra, scrub–tundra transition areas, tall alder on coastal slopes, and in tall scrub on glacial moraines.

Tall-scrub habitats are abundant in the Cook Inlet drainages study area, and Gray-cheeked Thrushes were recorded commonly during the point-count surveys in 2005 (see Section 41.5). Three habitats (Upland Moist Tall Alder Scrub, Upland Moist Tall Willow Scrub, and Riverine Tall Alder or Willow Scrub) were categorized as high value for Gray-cheeked Thrushes (Appendix 41.1D). Habitats considered to be of moderate value were Upland Moist Low Willow Scrub and Riverine Low Willow Scrub. All other mapped habitats were categorized as low or negligible value for Gray-cheeked Thrushes.

Varied Thrush . Across their range, Varied Thrushes breed in wet coastal forests and in dense forests in interior areas; coniferous, deciduous, and mixed forests are all used (BPIFWG, 1999; George, 2000). In western Alaska, Varied Thrushes are occasionally found in tall-scrub thickets.

Suitable wet forest habitats for Varied Thrushes are uncommon in the Cook Inlet drainages study area, and the species was recorded rarely during the point-count surveys in 2005 (see Section 41.5). Forest habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys, but two habitats (Upland and Lowland Spruce Forest and Upland and Lowland Moist Mixed Forest) were considered to be of moderate value for Varied Thrushes (Appendix 41.1D). All other mapped habitats were categorized as low or negligible value.

Blackpoll Warbler. In tundra regions in Alaska, Blackpoll Warblers often breed in riverine alder–willow thickets, with or without an overstory of riverine forest, and in deciduous scrub habitats in transition areas between taiga and tundra (Kessel, 1998; BPIFWG, 1999; Hunt and Eliason, 1999). Tall shrubs typically are heavily used, and lower shrubs are used to a lesser degree. Coniferous and deciduous forests and woodlands also are used in boreal forest areas.

In the Cook Inlet drainages study area, forest and riverine tall-scrub habitats are uncommon, and Blackpoll Warblers were recorded rarely during the point-count surveys in 2005 (see Section 41.5). Many of these habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys, but three habitats (Upland Moist Tall Alder Scrub, Upland Moist Tall Willow Scrub, and Riverine Tall Alder or Willow Scrub) were considered to be of moderate value for Blackpoll Warblers (Appendix 41.1D). All other mapped habitats were categorized as low or negligible value.

Rusty Blackbird. A bird of boreal forests, Rusty Blackbirds breed in wet coniferous and mixed forests where they use openings at scrub bogs, fens, and the marshy shores of lakes and ponds (Avery, 1995; BPIFWG, 1999). They prefer a tall-scrub or sapling-tree component in forest openings.

Wet, scrubby, forest openings suitable for Rusty Blackbirds are uncommon in the Cook Inlet drainages study area. These habitats were not adequately sampled (less than 10 point-counts) during the point-count surveys in 2005, and the species was not recorded in the area (see Section 41.5). Because the quality of the available habitats was considered low for this species and the species was not observed in the study area, but has the potential to occur there, all mapped habitats were considered to be of low or negligible value for Rusty Blackbirds (Appendix 41.1D).

41.1.8 Summary

The Cook Inlet drainages study area designated for wildlife habitat mapping encompasses 16 square kilometers. The corridor study area extends eastward from the Summit Lakes area in the Chigmit Mountains along the Williams Creek drainage to Williamsport, then crosses Iliamna Bay and runs southward along the eastern shoreline of Iliamna Bay to North Head; it then runs northward along the western shoreline of Iniskin Bay north of Knoll Head.

Twenty terrestrial and freshwater wildlife habitat types in the study area were mapped from aerial photography taken in October 2004 and September 2008. Habitat types were defined primarily by two variables (vegetation structure and physiographic setting). Tall-scrub habitats strongly dominate in the study area, and one habitat (Upland Moist Tall Alder Scrub) covers 80 percent of the study area. Three other habitats (Upland Dry Barrens, Upland Moist Dwarf Scrub, and Alpine Dry Barrens) cover another 14 percent of the study area. The remaining 16 habitat types, including forest, scrub, scrub-bog, meadow, marsh, and freshwater aquatic habitats are uncommon, each covering less than one percent of the study area. Prominent streams in the study area, all of which drain into Cook Inlet, include Williams Creek and the unnamed stream that drains the Y Valley area north of Knoll Head. The Y Valley stream supports anadromous fish populations and provides foraging opportunities for wildlife.

Seventeen marine wildlife habitat types in the study area were mapped using publicly available bathymetry and mapping data from the National Oceanic and Atmospheric Administration. Only one vegetated marine habitat (Protected Estuary) occurs in the study area; most of this type is supratidal saltmarsh that occurs above the mean higher high water mark. Another prominent habitat occurring in supratidal areas is Supratidal Cliff. The study area, as mapped at mean lower low water, is dominated by nearshore marine waters, and two habitats (Shallow and Deep Subtidal Waters) cover 50 percent of the study area. Three soft-sediment intertidal habitats (Protected Mud Flat, Protected Sand Flat, and Exposed Sand Flat) also are prominent, and together cover 39 percent of the study area. Other marine habitats in the study include gravel/sand beaches, rocky ramps and platforms, rocky cliffs, and various combinations of these habitats (e.g., rocky ramp–platform with gravel/sand beach) in both protected and exposed locations.

Habitat-value assessments were made for 61 bird and mammal species of concern (45 birds and 16 mammals) that have been recorded or are expected to occur in the Cook Inlet drainages study area. These 61 species were selected because of their protected status, conservation concern, sensitive/indicator status, management concern, and/or ecological importance. Habitat values were ranked for 39 of the 59 bird and mammal species that occur in terrestrial and freshwater habitats for each of the 20 terrestrial and freshwater wildlife habitat types mapped, and for 43 of the 61 bird and mammal species that occur in marine habitats for the 17 marine wildlife habitat types mapped. Habitat values were categorically ranked into four classes (high, moderate, low, and negligible value) based upon project-specific field data, whenever possible. When project-specific data were lacking, habitat values were determined by referencing habitat-use information in the scientific literature and/or using professional judgment based on field experience with the species in question in Alaska.

The most species-rich terrestrial and freshwater habitats in the Cook Inlet drainages study area are the forest types, which have the greatest number of bird and mammal species with moderate- or high-value rankings (17–18 of the 39 species assessed). These forested habitats, however, are uncommon in the study area. Six other habitats have relatively high numbers of bird and mammal species with moderate or high habitat rankings (11–15 species); these habitats include Rivers and Streams (Anadromous) and five low- and tall-scrub and meadow habitats in upland and riverine areas. These habitats also are uncommon in the study area. Another nine habitats have lower numbers of species with moderate or high habitat rankings (six–10 species); these habitats include Rivers and Streams, Lakes and Ponds, marsh, meadow, and scrub-bog habitats in lowland areas, and four dwarf- and tall-scrub habitats in upland and alpine settings. The most common terrestrial or freshwater habitat in the study (Upland Moist Tall Alder Scrub) has 10 species with moderate or high habitat rankings. Three barren habitats in alpine, upland, and riverine areas have the fewest numbers of bird and mammal species with moderate or high habitat rankings (one–four species).

For marine habitats, the most species-rich are the soft-sediment habitats. Two habitats (Protected Mud Flat and Protected Sand Flat) have the greatest numbers of bird and mammal species of concern with moderate- or high-value habitat rankings (26–27 of the 43 species assessed). Eight other habitats have relatively high numbers of bird and mammal species with moderate or high habitat rankings (12–19 species); these habitats include Protected Estuary, Exposed Sand Flat, both Shallow and Deep Subtidal

Waters, the exposed and protected forms of Gravel/Sand Beach, and the protected forms of Rocky Cliff and Rocky Ramp–Platform when associated with Gravel/Sand Beach. Seven habitats have the fewest numbers of bird and mammal species with moderate or high habitat rankings three–eight species); in this set are both the exposed and protected forms of Rocky Cliff and Rocky Ramp–Platform, the exposed forms of Rocky Cliff and Rocky Ramp–Platform when associated with Gravel/Sand Beach, and Supratidal Cliffs.

The Cook Inlet drainages study area provides at least some suitable habitat (moderate and/or high habitat-value rankings) for a set of 13 terrestrial mammal species (wolf, red fox, river otter, wolverine, black bear, brown bear, moose, arctic ground squirrel, red squirrel, beaver, northern red-backed vole, tundra vole, and snowshoe hare) and for three marine mammal species (sea otter, harbor seal, and harbor porpoise).

Black bears favor habitats that provide cover and in the Cook Inlet drainages study area, most forest and tall-scrub habitats were considered to be of high value for black bears. Other forest, scrub, scrub-bog, meadow, and marsh habitats, and Rivers and Streams (Anadromous) were considered to be of moderate value for black bears. None of the marine habitats in the study area was considered to be of high or moderate value for black bears. In contrast, brown bears are known to use a broader array of habitats than black bears and 15 terrestrial and freshwater habitats in the study area were considered to be of moderate value for brown bears. One habitat (Rivers and Streams [Anadromous]) was considered to be of high value for brown bears because salmon streams are heavily used by foraging brown bears in late summer. Five marine habitats were considered to be of moderate value for brown bears and included beaches, cliffs with beaches, and supratidal estuarine habitats (the latter providing important plant foods for brown bears during early spring). Habitats suitable for black and brown bears are common and widespread in the study area.

For moose, low and/or tall willow-scrub habitats, and Lakes and Ponds were considered to be of high value, primarily for forage. These high-value moose habitats, however, are uncommon in the study area. Other scrub, scrub-bog, forest, meadow, and marsh habitats were considered to be of moderate value for moose, also for forage. None of the marine habitats in the study area was considered to be of high or moderate value for moose.

For marine mammals, a single marine habitat (Deep Subtidal Waters) was considered to be of moderate value for harbor porpoises for foraging. Two habitats (Shallow and Deep Subtidal Waters) were considered to be of moderate value for sea otters for foraging. No marine habitat in the study area was considered to be of high value for these two species. For harbor seals, two marine habitats (Shallow and Deep Subtidal Waters) were considered to be of high value for foraging and one habitat (Protected Sand Flat) was categorized as moderate value.

For birds, the Cook Inlet drainages study area provides at least some suitable habitat (moderate and/or high habitat-value rankings) for a set of four tree-nesting raptor species (Bald Eagle, Northern Goshawk, Merlin, Great Horned Owl), two cliff-nesting raptor species (Golden Eagle, Peregrine Falcon), 16 waterbird species (Trumpeter Swan, American Wigeon, Mallard, Northern Pintail, Green-winged Teal, Greater Scaup, Harlequin Duck, Surf Scoter, Black Scoter, Long-tailed Duck, Red-throated Loon, Horned Grebe, Red-faced Cormorant, Pelagic Cormorant, Arctic Tern, Marbled Murrelet), eleven shorebird species (American Golden-Plover, Black Oystercatcher, Lesser Yellowlegs, Whimbrel, Hudsonian Godwit, Marbled Godwit, Black Turnstone, Surfbird, Rock Sandpiper, Dunlin, Short-billed Dowitcher), and seven landbird species (Spruce Grouse, Willow Ptarmigan, Rock Ptarmigan, Olive-sided Flycatcher, Gray-cheeked Thrush, Varied Thrush, and Blackpoll Warbler).

Terrestrial and freshwater habitats considered suitable for nesting and/or foraging by tree-nesting raptors (forests, some scrub and barren habitats, meadows, marshes, lacustrine and riverine waterbodies) are uncommon in the study area. In contrast, marine habitats considered suitable for foraging by tree-nesting raptors (estuaries, mud and sand flats, gravel/sand beaches, rocky cliffs, and subtidal waters) are common and widespread in the study area. For cliff-nesting raptors, a set of higher elevation, open dwarf-scrub and barren habitats, and some forest, scrub, scrub-bog, meadow, marsh, and aquatic habitats were considered suitable for nesting and/or foraging. These terrestrial and freshwater habitats are uncommon in the study area. Marine habitats considered suitable for foraging by cliff-nesting raptors, however, are common and occur throughout the study area. These habitats include estuaries, mud and sand flats, rocky cliffs, and subtidal waters.

For breeding and migrant waterbirds, several terrestrial and freshwater habitats, including anadromous streams and associated riverine habitats were considered to be of high value, and lacustrine waterbodies were considered to be of moderate value. These suitable habitats for breeding and migrant waterbirds are uncommon in the study area. In contrast, a wide variety of marine habitats is available and considered suitable for migrant and overwintering waterbirds. These suitable marine habitats include estuaries, mud and sand flats, beaches, rocky ramps, rocky platforms, rocky cliffs, and subtidal waters.

Open terrestrial habitats considered suitable for breeding shorebirds in the study area are limited in occurrence and include many of the higher elevation, dwarf-scrub and barren habitats. Marine habitats, however, that were considered suitable for migrant shorebirds, and for a few species of overwintering and breeding shorebirds, are common and widespread in the study area. The marine habitats considered suitable for shorebirds include estuaries, mud and sand flats, beaches, rocky ramps, rocky platforms, and rocky cliffs.

Habitats suitable for breeding landbirds in the study area include forests, and tall-scrub, low-scrub, dwarf-scrub, and barren types in a variety of physiographic settings. Tall-scrub habitats suitable for some breeding landbird species are common and widespread across the study area. Forested and open habitats suitable for other breeding landbirds are uncommon. None of the marine habitats mapped in the study area was evaluated for use by landbirds because the landbird species addressed in this study do not occur in marine habitats.

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41.1.10 Glossary

Abiotic—non-biological

Crepuscular—refers to animals that are active during the twilight hours of dusk and dawn

Crustose (lichen)—lichens that grow horizontally, appressed to the growing surface, which is often bare rocks or soil

Epizootic—a disease outbreak affecting many animals at the same time, often with the implication that the disease could be transferred to human populations

Ericaceous—a vascular plant belonging to the family Ericaceae; in Alaska, these plants are typically dwarf or low-growing shrubs with characteristic urn-shaped flowers (e.g., blueberry)

Fluvial—geomorphological features created by rivers and streams; also the processes of landform development through the action of rivers and streams

Foliose (lichen)—lichens that grow in a wavy, leaf-like form elevated above the growing surface

Forb—any herbaceous that is not a graminoid (see definition below)

Frugivorous—refers to animal species that eat fruits, either entirely or as part of their diet

Fruticose (lichen)—lichens that grow erect in a shrub-like form with branching stalks

Graminoid—grass and grass-like plants (including sedges and rushes)

Lacustrine—associated with lakes and ponds and landscape features derived from the development of lakes and ponds

Mesic—moderately moist conditions, not wet and not dry

Monocotelydon—one of the two major groups of flowering plants; monocotelydonous plants are characterized by one leaf in the embryonic stage; in Alaska, most "monocots" are grass or grass-like plants (e.g., sedges and rushes, but also lilies and irises)

Orthophoto—a digital image of an aerial photo in which corrections have been to account for the camera angle and curvature of the earth so as to accurately represent the area displayed on a flat plane (i.e., computer screen)

Parturition—in mammalian species, the process of giving birth to offspring

Phenology—the study of recurring biological phenomena in plant and animal species due to changing weather conditions (e.g., seasonal changes in plant growth)

Photosignature—in the limited sense used here, a combination of color and texture on an aerial photo indicative of a particular vegetation, physiographic, or surface-form type

Physiography—in the limited sense used here, a categorization of landforms/topographic regions into classes, which are based largely on the geomorphological forces shaping the landforms in those areas (e.g., alpine, subalpine, upland, lowland, lacustrine [see above], and riverine [see below])

Rhizomatous—refers to a vascular plant that produces rhizomes (horizontal stems that often grow underground)

Riverine—associated with rivers and streams and landscape features developed from the actions of rivers and streams

Sympatric—typically in reference to two species, often similar species, occurring together in the same geographic region

Ungulate—a hoofed mammal species (e.g., moose, caribou)

TABLES

TABLE 41.1-1
Criteria for the Selection of Bird and Mammal Species for Habitat-value Assessments, Cook Inlet Drainages Study Area, 2010

Common Name	Scientific Name	Protected Species [a]	Conserv. Concern [b]	Sensitive Species [c]	Manage. Concern [d]	Ecol. Important [e]
Birds						
Trumpeter Swan	***Cygnus buccinator***			**X**		
American Wigeon	***Anas americana***				**X**	
Mallard	***Anas platyrhynchos***				**X**	
Northern Pintail	***Anas acuta***				**X**	
Green-winged Teal	***Anas crecca***				**X**	
Greater Scaup	***Aythya marila***				**X**	
Steller's Eider	***Polysticta stelleri***	**X**	**X**			
Harlequin Duck	***Histrionicus histrionicus***			**X**		
Surf Scoter	***Melanitta perspicillata***		**X**			
Black Scoter	***Melanitta americana***		**X**			
Long-tailed Duck	***Clangula hyemalis***		**X**			
Spruce Grouse	***Falcipennis canadensis***				**X**	
Willow Ptarmigan	***Lagopus lagopus***				**X**	
Rock Ptarmigan	***Lagopus muta***				**X**	
Red-throated Loon	***Gavia stellata***		**X**			
Horned Grebe	***Podiceps auritus***		**X**			
Red-faced Cormorant	***Phalacrocorax urile***		**X**			
Pelagic Cormorant	***Phalacrocorax pelagicus***		**X**			
Bald Eagle	***Haliaeetus leucocephalus***	**X**				
Northern Goshawk	***Accipiter gentilis***					**X**
Golden Eagle	***Aquila chrysaetos***	**X**	**X**			
Merlin	***Falco columbarius***					**X**
Gyrfalcon	***Falco rusticolus***		**X**			
Peregrine Falcon	***Falco peregrinus***		**X**			
American Golden-Plover	***Pluvialis dominica***		**X**			
Black Oystercatcher	***Haematopus bachmani***		**X**			
Solitary Sandpiper	***Tringa solitaria***		**X**			
Lesser Yellowlegs	***Tringa flavipes***		**X**			
Whimbrel	***Numenius phaeopus***		**X**			
Hudsonian Godwit	***Limosa haemastica***		**X**			
Marbled Godwit	***Limosa fedoa***		**X**			
Black Turnstone	***Arenaria melanocephala***		**X**			
Surfbird	***Aphriza virgata***		**X**			

Common Name	Scientific Name	Protected Species [a]	Conserv. Concern [b]	Sensitive Species [c]	Manage. Concern [d]	Ecol. Important [e]
Rock Sandpiper	***Calidris ptilocnemis***		X			
Dunlin	***Calidris alpina***		X			
Short-billed Dowitcher	***Limnodromus griseus***		X			
Arctic Tern	***Sterna paradisaea***		X			
Marbled Murrelet	***Brachyramphus marmoratus***		X			
Great Horned Owl	***Bubo virginianus***					X
Black-backed Woodpecker	***Picoides arcticus***		X			
Olive-sided Flycatcher	***Contopus cooperi***		X			
Gray-cheeked Thrush	***Catharus minimus***		X			
Varied Thrush	***Ixoreus naevius***		X			
Blackpoll Warbler	***Dendroica striata***		X			
Rusty Blackbird	***Euphagus carolinus***		X			
Mammals						
Wolf	***Canis lupus***				X	X
Red fox	***Vulpes vulpes***					X
Northern sea otter	***Enhydra lutris kenyoni***	X	X			
River otter	***Lontra canadensis***				X	
Wolverine	***Gulo gulo***				X	
Harbor seal	***Phoca vitulina***	X				
Black bear	***Ursus americanus***				X	
Brown bear	***Ursus arctos***				X	X
Harbor porpoise	***Phocoena phocoena***	X				
Moose	***Alces alces***				X	X
Arctic ground squirrel	***Spermophilus parryii***				X	X
Red squirrel	***Tamiasciurus hudsonicus***					X
Beaver	***Castor canadensis***				X	X
Northern red-backed vole	***Myodes rutilus***					X
Tundra vole	***Microtus oeconomus***					X
Snowshoe hare	***Lepus americanus***				X	X

Notes:

a. Legally protected under the Endangered Species Act, Marine Mammal Protection Act, or the Bald and Golden Eagle Protection Act.

b. Species is of conservation concern (see Chapter 45 for more information).

c. Species is sensitive to human disturbance and development as a breeder in freshwater habitats and serves as an indicator of environmental health.

d. Species is of management concern for subsistence and/or sport hunting/trapping.

e. Ecologically important as predator or prey (not otherwise represented by another species under one of the other criteria above) or because of other prominent ecosystem effects.

TABLE 41.1-2
Wildlife Habitat-value Categories, Cook Inlet Drainages Study Area, 2010

Wildlife Group	Value Class	Ranking Score	Description
Birds	High value	3	Known to be frequently used for nesting and/or foraging during the breeding season; these habitats also are often used during migration or by wintering birds
	Moderate value	2	Moderate-value habitats would be regularly used during the breeding and/or nonbreeding seasons but less so than high-value habitats
	Low value	1	Low-value habitats would see little use by the species under consideration
	Negligible value	0	The species is not expected to occur, or will occur vary rarely, in negligible-value habitats
Mammals	High value	3	Known to be frequently used for breeding, calving, denning, etc., and/or foraging during critical seasons
	Moderate value	2	Moderate-value habitats would be regularly used (e.g., especially for foraging) but less so than high-value habitats
	Low value	1	Low-value habitats would see little use by the species under consideration
	Negligible value	0	The species is not expected to occur, or will occur very rarely, in negligible-value habitats

TABLE 41.1-3
Areas (Square Kilometers) and Relative Abundance (Percent of Study Area) for Mapped Terrestrial and Freshwater Wildlife Habitat Types, Cook Inlet Drainages Study Area, 2010

Habitat Type	Area (Square Kilometers)	Percent of Study Area
Alpine Dry Barrens	0.13	1.21
Alpine Moist Dwarf Scrub	0.08	0.75
Upland Dry Barrens	1.05	9.81
Upland Dry Dwarf Shrub-Lichen Scrub	<0.01	0.04
Upland Moist Dwarf Scrub	0.33	3.08
Upland Moist Low Willow Scrub	<0.01	0.02
Upland Moist Tall Alder Scrub	8.61	80.47
Upland Moist Tall Willow Scrub	0.02	0.19
Upland and Lowland Spruce Forest	0.09	0.84
Upland and Lowland Moist Mixed Forest	<0.01	0.04
Rivers and Streams	0.04	0.37
Rivers and Streams (Anadromous)	0.04	0.37
Riverine Barrens	0.09	0.84
Riverine Wet Graminoid–Shrub Meadow	0.01	0.09
Riverine Low Willow Scrub	0.01	0.09
Riverine Tall Alder or Willow Scrub	0.10	0.93
Lakes and Ponds	0.02	0.19
Lowland Sedge–Forb Marsh	0.02	0.19
Lowland Ericaceous Scrub Bog	0.04	0.37
Lowland Wet Graminoid–Shrub Meadow	0.01	0.09
Total	10.70	100.00

TABLE 41.1-4
Areas (Square Kilometers) and Relative Abundance (Percent of Study Area) for Mapped Marine Wildlife Habitat Types, Cook Inlet Drainages Study Area, 2010

Habitat Type	Area (Square Kilometers)	Percent of Study Area
Supratidal Cliff [a]	**see note**	**see note**
Protected Estuary	0.04	0.77
Protected Mud Flat	0.62	12.40
Protected Sand Flat	1.15	23.11
Protected Gravel/Sand Beach	0.05	1.09
Protected Rocky Ramp–Platform with Gravel/Sand Beach	0.04	0.77
Protected Rocky Ramp–Platform	0.01	0.18
Protected Rocky Cliff with Gravel/Sand Beach	0.13	2.51
Protected Rocky Cliff	0.01	0.12
Exposed Sand Flat	0.18	3.53
Exposed Gravel/Sand Beach	0.02	0.37
Exposed Rocky Ramp–Platform with Gravel/Sand Beach	0.02	0.45
Exposed Rocky Ramp–Platform	0.06	1.21
Exposed Rocky Cliff with Gravel/Sand Beach	0.14	2.77
Exposed Rocky Cliff	0.04	0.76
Shallow Subtidal Waters	1.46	29.14
Deep Subtidal Waters	1.04	20.83
Total	5.00	100.00

Note:

a. Supratidal Cliff was mapped as a line, not a polygon, hence an area for this habitat type cannot be determined; the calculated length of Supratidal Cliff habitats in the study area was 27.37 kilometers.

FIGURES

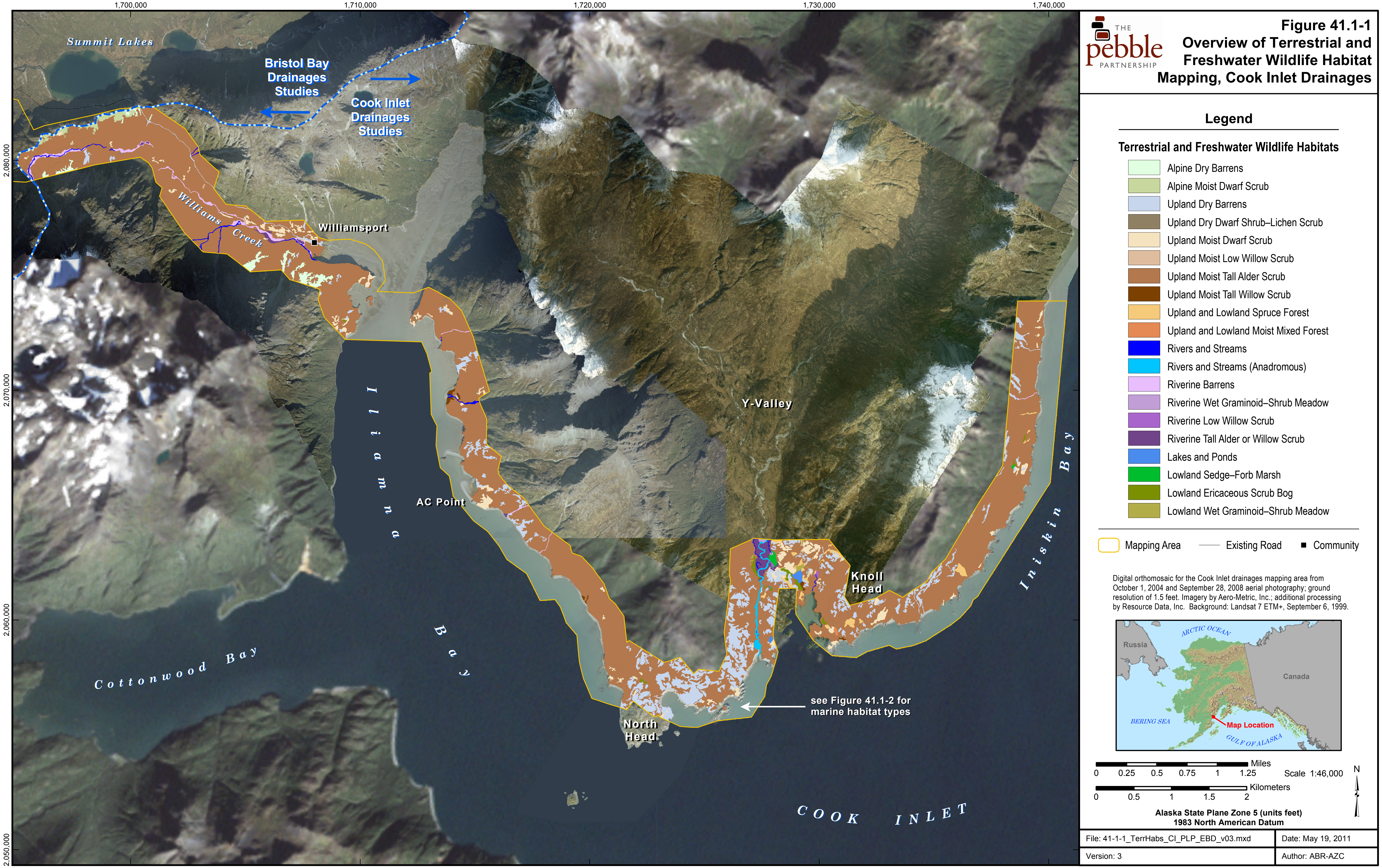

Figure 41.1-1
Overview of Terrestrial and Freshwater Wildlife Habitat Mapping, Cook Inlet Drainages

Figure 41.1-2
Overview of Marine Wildlife Habitat Mapping, Cook Inlet Drainages

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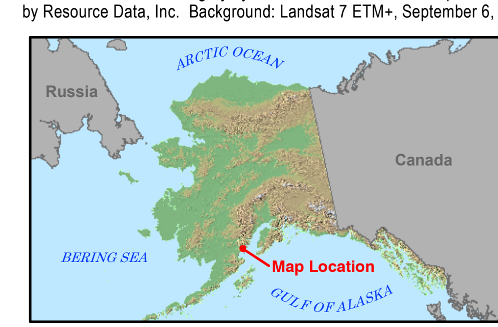
Legend

Marine Wildlife Habitats

- Supratidal Cliffs
- Protected Estuary
- Protected Mud Flat
- Protected Sand Flat
- Protected Gravel/Sand Beach
- Protected Rocky Ramp–Platform with Gravel/Sand Beach
- Protected Rocky Ramp–Platform
- Protected Rocky Cliff with Gravel/Sand Beach
- Protected Rocky Cliff
- Exposed Sand Flat
- Exposed Gravel/Sand Beach
- Exposed Rocky Ramp–Platform with Gravel/Sand Beach
- Exposed Rocky Ramp–Platform
- Exposed Rocky Cliff with Gravel/Sand Beach
- Exposed Rocky Cliff
- Deep Subtidal Waters (>1.8 m)
- Shallow Subtidal Waters (≤1.8 m)

Mapping Area — Existing Road — Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.



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Kilometers: 0 0.25 0.5 0.75 1 1.25

Scale 1:33,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-2_MarineHabs_CI_PLP_EBD_v03.mxd	Date: May 19, 2011
Version: 3	Author: ABR-AZC

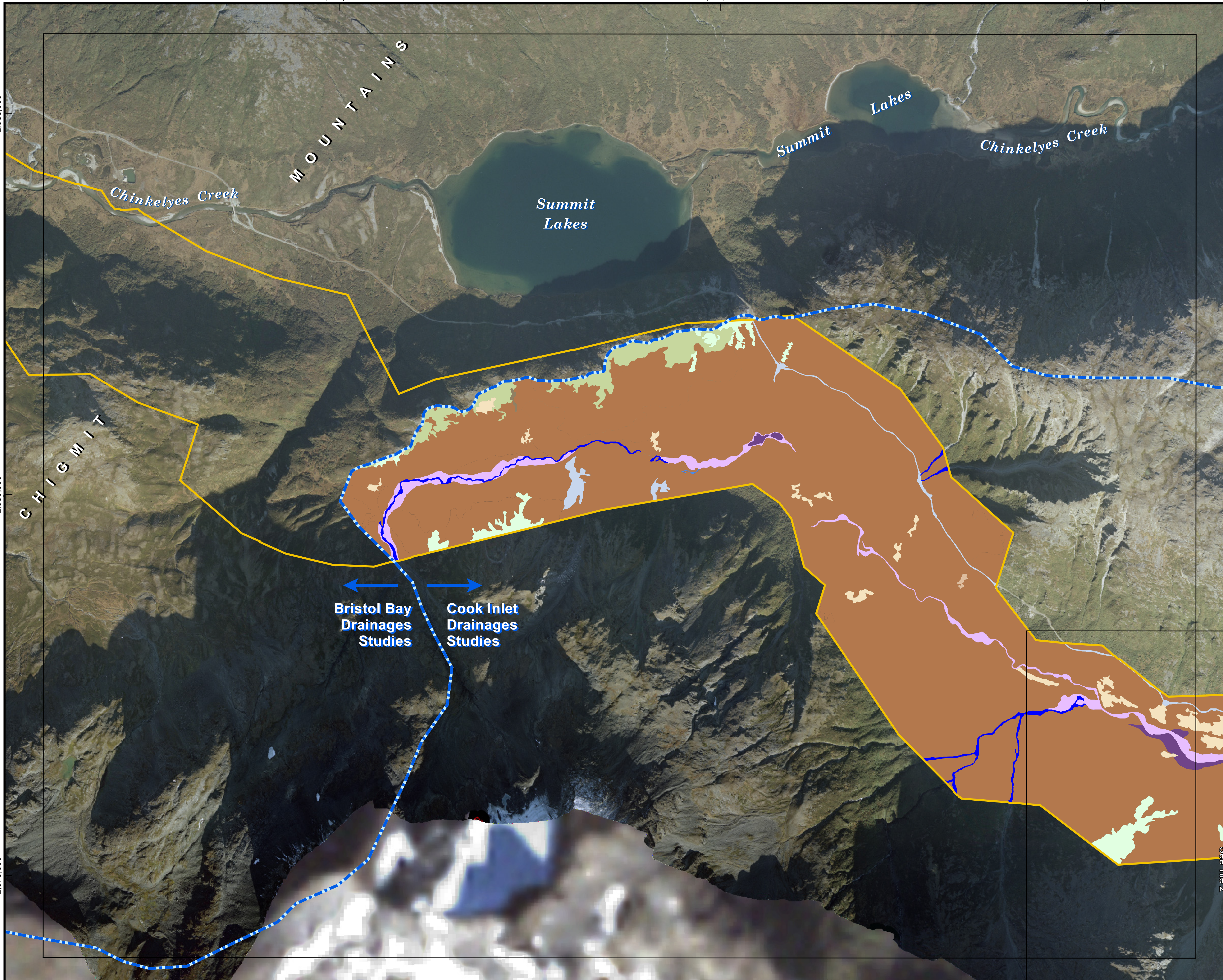

Figure 41.1-3a
Wildlife Habitat Mapping, Terrestrial/Freshwater and Marine Types, Cook Inlet Drainages

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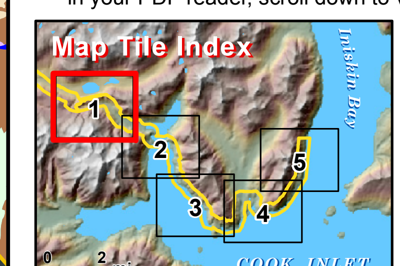
Legend

Wildlife Habitats – Tile 1

- Alpine Dry Barrens
- Alpine Moist Dwarf Scrub
- Upland Dry Barrens
- Upland Dry Dwarf Shrub–Lichen Scrub
- Upland Moist Dwarf Scrub
- Upland Moist Low Willow Scrub
- Upland Moist Tall Alder Scrub
- Upland Moist Tall Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Moist Mixed Forest
- Rivers and Streams
- Rivers and Streams (Anadromous)
- Riverine Barrens
- Riverine Wet Graminoid–Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder or Willow Scrub
- Lakes and Ponds
- Lowland Sedge–Forb Marsh
- Lowland Ericaceous Scrub Bog
- Lowland Wet Graminoid–Shrub Meadow
- Supratidal Cliffs
- Protected Estuary
- Protected Mud Flat
- Protected Sand Flat
- Protected Gravel/Sand Beach
- Protected Rocky Ramp–Platform with Gravel/Sand Beach
- Protected Rocky Ramp–Platform
- Protected Rocky Cliff with Gravel/Sand Beach
- Protected Rocky Cliff
- Exposed Sand Flat
- Exposed Gravel/Sand Beach
- Exposed Rocky Ramp–Platform with Gravel/Sand Beach
- Exposed Rocky Ramp–Platform
- Exposed Rocky Cliff with Gravel/Sand Beach
- Exposed Rocky Cliff
- Shallow Subtidal Waters (≤1.8 m)
- Deep Subtidal Waters (>1.8 m)

Mapping Area | Map Tile | Community

Note: When viewing the digital version of this map series in your PDF reader, scroll down to view the next map tile.



Imagery notes: Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

N

Feet: 0, 500, 1,000, 1,500, 2,000

Meters: 0, 200, 400, 600

Scale 1:16,000

Alaska State Plane Zone 5 (units feet), 1983 North American Datum

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Version: 3	Author: ABR-AZC

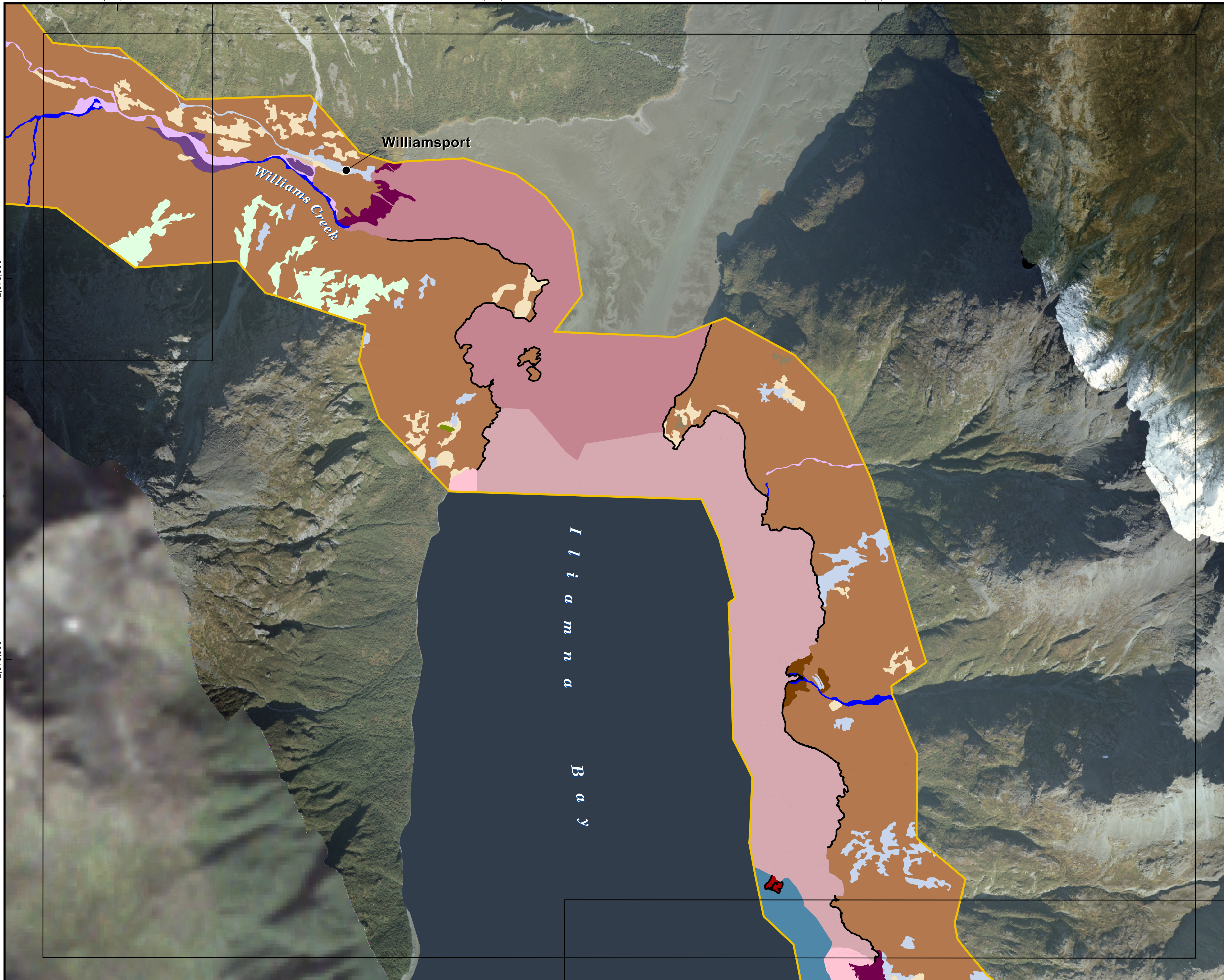


Figure 41.1-3b
Wildlife Habitat Mapping, Terrestrial/Freshwater and Marine Types, Cook Inlet Drainages

THE pebble PARTNERSHIP

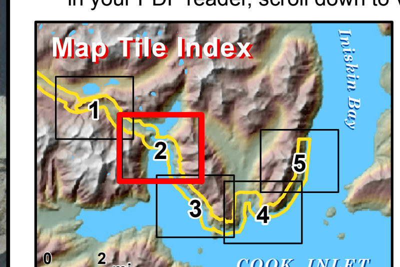
Legend

Wildlife Habitats – Tile 2

- Alpine Dry Barrens
- Alpine Moist Dwarf Scrub
- Upland Dry Barrens
- Upland Dry Dwarf Shrub–Lichen Scrub
- Upland Moist Dwarf Scrub
- Upland Moist Low Willow Scrub
- Upland Moist Tall Alder Scrub
- Upland Moist Tall Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Moist Mixed Forest
- Rivers and Streams
- Rivers and Streams (Anadromous)
- Riverine Barrens
- Riverine Wet Graminoid–Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder or Willow Scrub
- Lakes and Ponds
- Lowland Sedge–Forb Marsh
- Lowland Ericaceous Scrub Bog
- Lowland Wet Graminoid–Shrub Meadow
- Supratidal Cliffs
- Protected Estuary
- Protected Mud Flat
- Protected Sand Flat
- Protected Gravel/Sand Beach
- Protected Rocky Ramp–Platform with Gravel/Sand Beach
- Protected Rocky Ramp–Platform
- Protected Rocky Cliff with Gravel/Sand Beach
- Protected Rocky Cliff
- Exposed Sand Flat
- Exposed Gravel/Sand Beach
- Exposed Rocky Ramp–Platform with Gravel/Sand Beach
- Exposed Rocky Ramp–Platform
- Exposed Rocky Cliff with Gravel/Sand Beach
- Exposed Rocky Cliff
- Shallow Subtidal Waters (≤1.8 m)
- Deep Subtidal Waters (>1.8 m)

Mapping Area | Map Tile | Community

Note: When viewing the digital version of this map series in your PDF reader, scroll down to view the next map tile.



Imagery notes: Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

N

Feet: 0 500 1,000 1,500 2,000

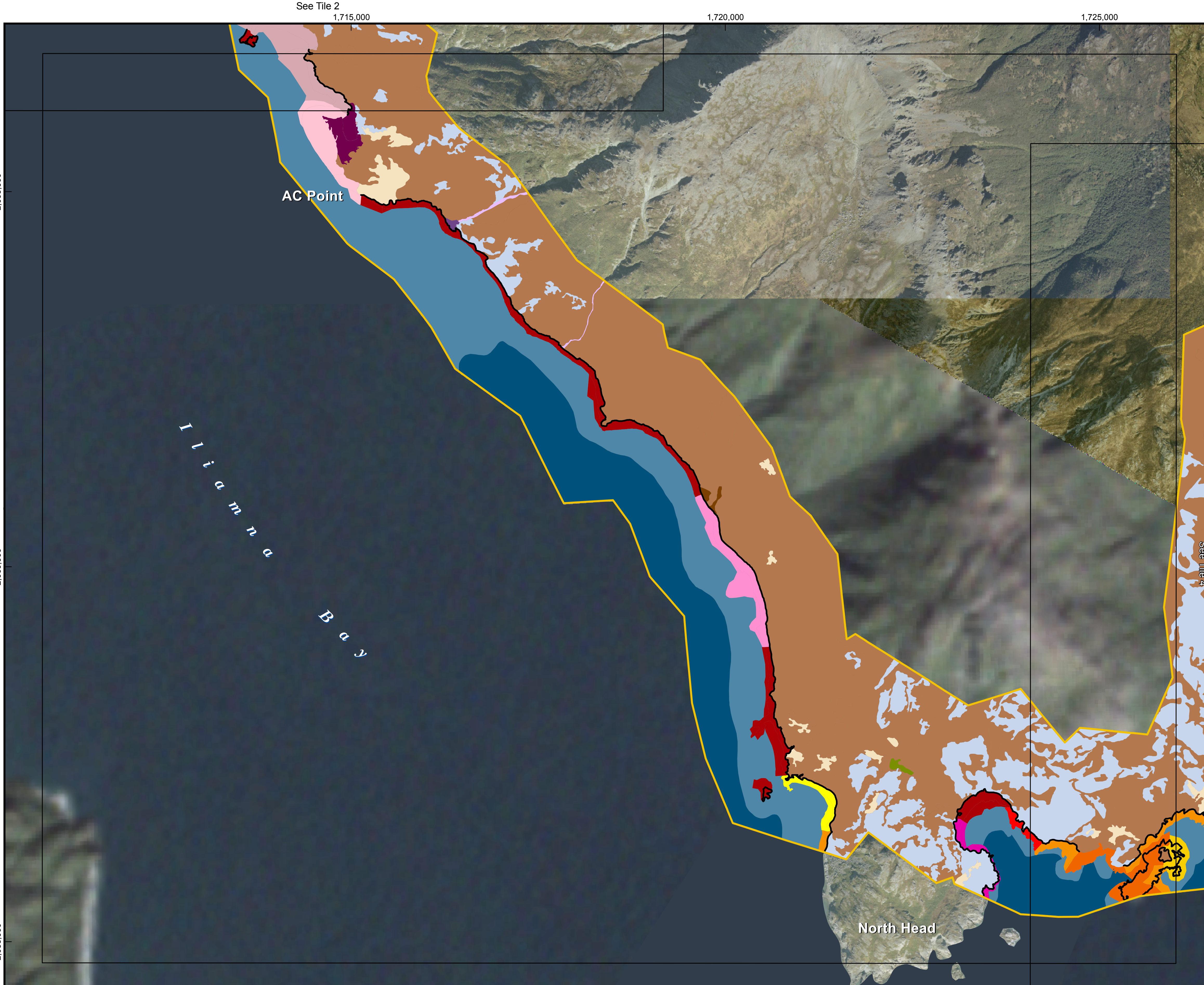
Meters: 0 200 400 600

Scale 1:16,000

Alaska State Plane Zone 5 (units feet), 1983 North American Datum

File: 41-1-3_HabTiles_CI_PLP_EBD_v03.mxd	Date: May 20, 2011
Version: 3	Author: ABR-AZC

Figure 41.1-3c
Wildlife Habitat Mapping, Terrestrial/Freshwater and Marine Types, Cook Inlet Drainages



Legend

Wildlife Habitats – Tile 3

- Alpine Dry Barrens
- Alpine Moist Dwarf Scrub
- Upland Dry Barrens
- Upland Dry Dwarf Shrub–Lichen Scrub
- Upland Moist Dwarf Scrub
- Upland Moist Low Willow Scrub
- Upland Moist Tall Alder Scrub
- Upland Moist Tall Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Moist Mixed Forest
- Rivers and Streams
- Rivers and Streams (Anadromous)
- Riverine Barrens
- Riverine Wet Graminoid–Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder or Willow Scrub
- Lakes and Ponds
- Lowland Sedge–Forb Marsh
- Lowland Ericaceous Scrub Bog
- Lowland Wet Graminoid–Shrub Meadow
- Supratidal Cliffs
- Protected Estuary
- Protected Mud Flat
- Protected Sand Flat
- Protected Gravel/Sand Beach
- Protected Rocky Ramp–Platform with Gravel/Sand Beach
- Protected Rocky Ramp–Platform
- Protected Rocky Cliff with Gravel/Sand Beach
- Protected Rocky Cliff
- Exposed Sand Flat
- Exposed Gravel/Sand Beach
- Exposed Rocky Ramp–Platform with Gravel/Sand Beach
- Exposed Rocky Ramp–Platform
- Exposed Rocky Cliff with Gravel/Sand Beach
- Exposed Rocky Cliff
- Shallow Subtidal Waters (≤1.8 m)
- Deep Subtidal Waters (>1.8 m)

Mapping Area · Map Tile · Community

Note: When viewing the digital version of this map series in your PDF reader, scroll down to view the next map tile.

Imagery notes: Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

N

Feet: 0 500 1,000 1,500 2,000
Meters: 0 200 400 600

Scale 1:16,000

Alaska State Plane Zone 5 (units feet), 1983 North American Datum

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Version: 3	Author: ABR-AZC

See Tile 5

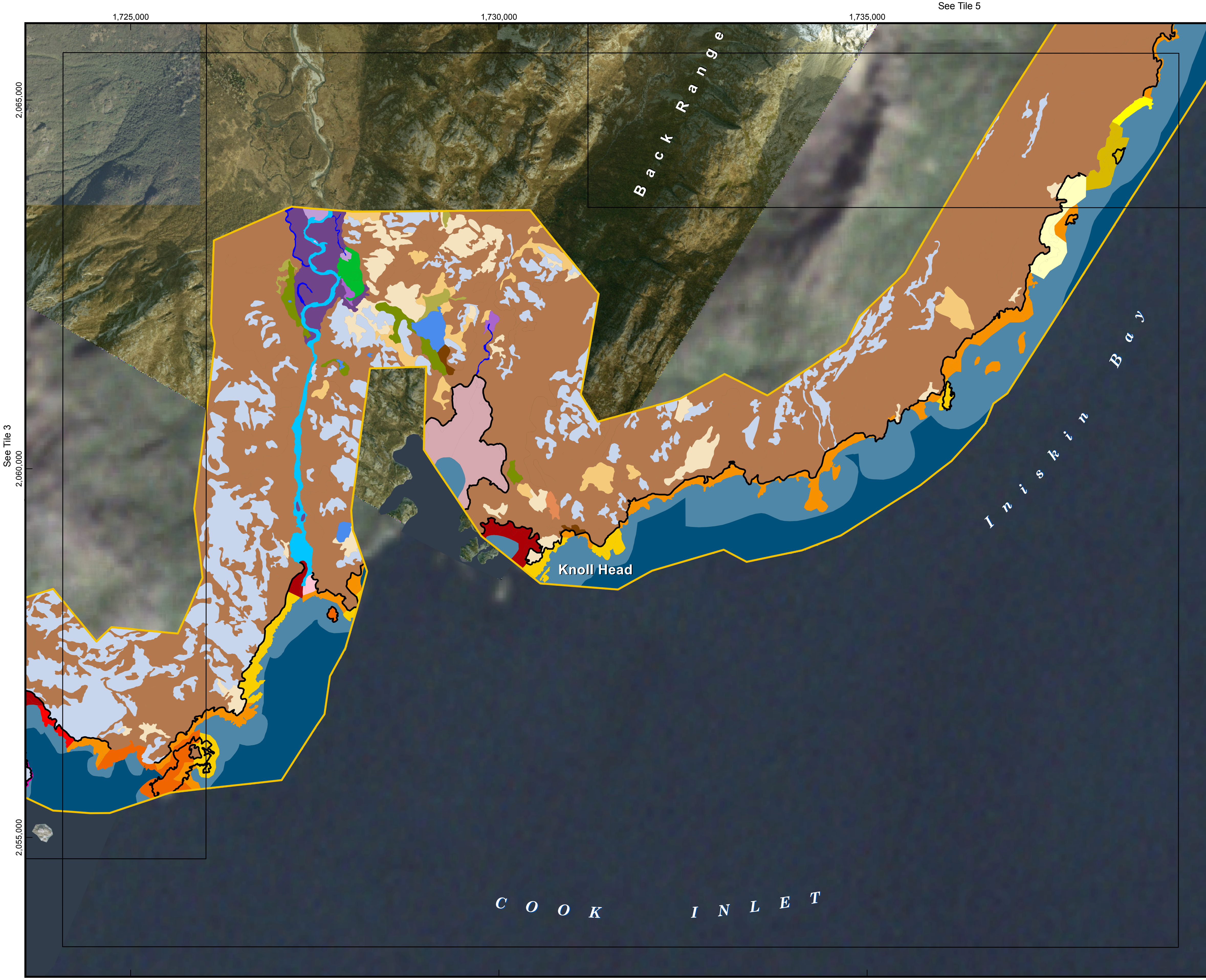


Figure 41.1-3d
Wildlife Habitat Mapping, Terrestrial/Freshwater and Marine Types, Cook Inlet Drainages

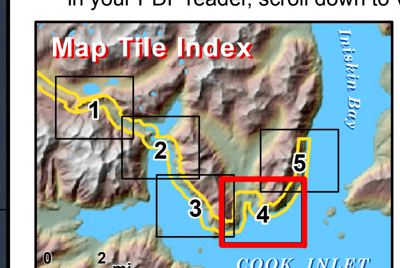
Legend

Wildlife Habitats – Tile 4

- Alpine Dry Barrens
- Alpine Moist Dwarf Scrub
- Upland Dry Barrens
- Upland Dry Dwarf Shrub–Lichen Scrub
- Upland Moist Dwarf Scrub
- Upland Moist Low Willow Scrub
- Upland Moist Tall Alder Scrub
- Upland Moist Tall Willow Scrub
- Upland and Lowland Spruce Forest
- Upland and Lowland Moist Mixed Forest
- Rivers and Streams
- Rivers and Streams (Anadromous)
- Riverine Barrens
- Riverine Wet Graminoid–Shrub Meadow
- Riverine Low Willow Scrub
- Riverine Tall Alder or Willow Scrub
- Lakes and Ponds
- Lowland Sedge–Forb Marsh
- Lowland Ericaceous Scrub Bog
- Lowland Wet Graminoid–Shrub Meadow
- Supratidal Cliffs
- Protected Estuary
- Protected Mud Flat
- Protected Sand Flat
- Protected Gravel/Sand Beach
- Protected Rocky Ramp–Platform with Gravel/Sand Beach
- Protected Rocky Ramp–Platform
- Protected Rocky Cliff with Gravel/Sand Beach
- Protected Rocky Cliff
- Exposed Sand Flat
- Exposed Gravel/Sand Beach
- Exposed Rocky Ramp–Platform with Gravel/Sand Beach
- Exposed Rocky Ramp–Platform
- Exposed Rocky Cliff with Gravel/Sand Beach
- Exposed Rocky Cliff
- Shallow Subtidal Waters (≤1.8 m)
- Deep Subtidal Waters (>1.8 m)

Mapping Area | Map Tile | Community

Note: When viewing the digital version of this map series in your PDF reader, scroll down to view the next map tile.



Imagery notes: Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

N

0 500 1,000 1,500 2,000 Feet

0 200 400 600 Meters

Scale 1:16,000

Alaska State Plane Zone 5 (units feet), 1983 North American Datum

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Version: 3	Author: ABR-AZC

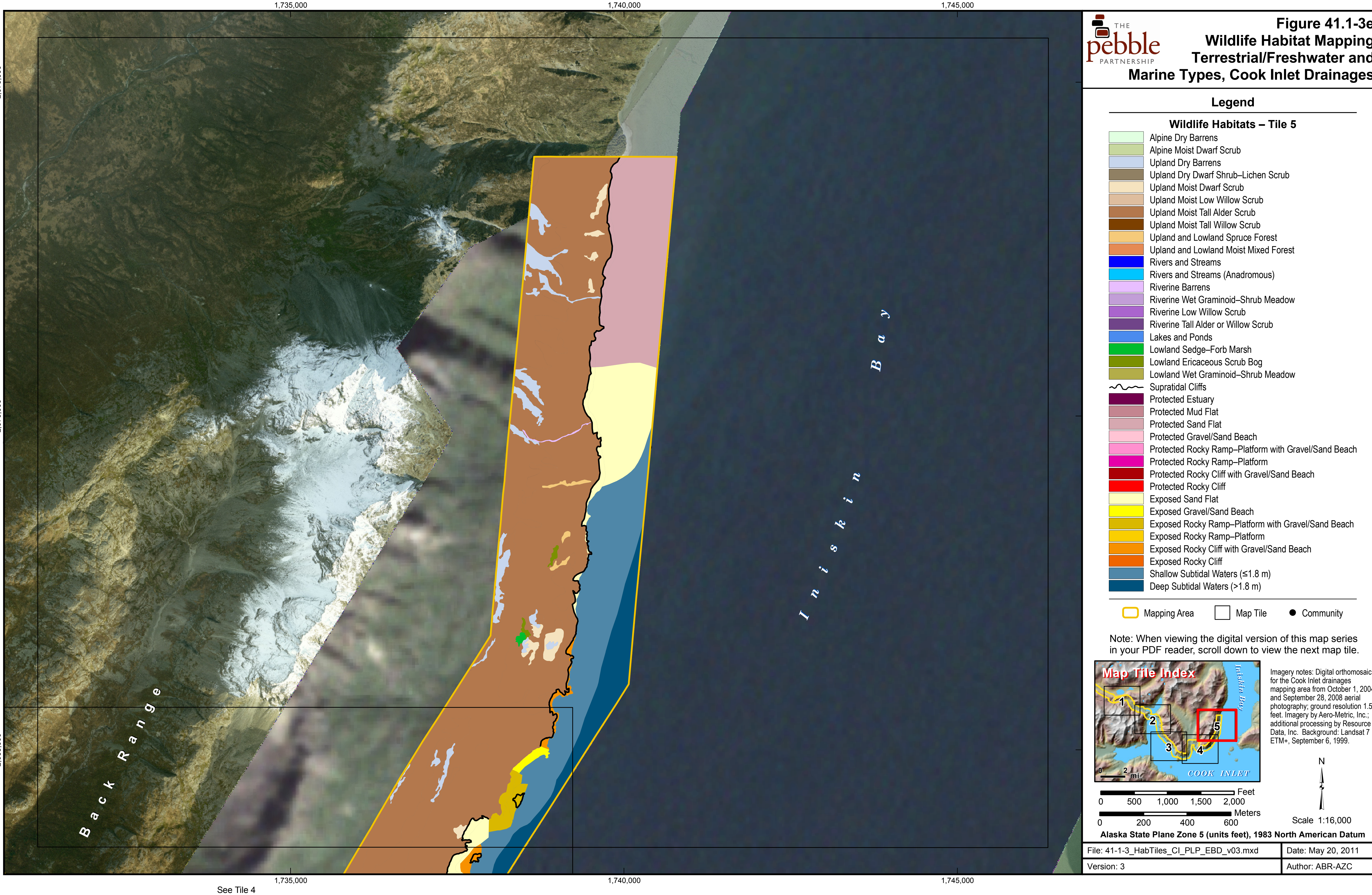

Figure 41.1-3e
Wildlife Habitat Mapping, Terrestrial/Freshwater and Marine Types, Cook Inlet Drainages
THE pebble PARTNERSHIP
Legend
Wildlife Habitats – Tile 5
Alpine Dry Barrens
Alpine Moist Dwarf Scrub
Upland Dry Barrens
Upland Dry Dwarf Shrub–Lichen Scrub
Upland Moist Dwarf Scrub
Upland Moist Low Willow Scrub
Upland Moist Tall Alder Scrub
Upland Moist Tall Willow Scrub
Upland and Lowland Spruce Forest
Upland and Lowland Moist Mixed Forest
Rivers and Streams
Rivers and Streams (Anadromous)
Riverine Barrens
Riverine Wet Graminoid–Shrub Meadow
Riverine Low Willow Scrub
Riverine Tall Alder or Willow Scrub
Lakes and Ponds
Lowland Sedge–Forb Marsh
Lowland Ericaceous Scrub Bog
Lowland Wet Graminoid–Shrub Meadow
Supratidal Cliffs
Protected Estuary
Protected Mud Flat
Protected Sand Flat
Protected Gravel/Sand Beach
Protected Rocky Ramp–Platform with Gravel/Sand Beach
Protected Rocky Ramp–Platform
Protected Rocky Cliff with Gravel/Sand Beach
Protected Rocky Cliff
Exposed Sand Flat
Exposed Gravel/Sand Beach
Exposed Rocky Ramp–Platform with Gravel/Sand Beach
Exposed Rocky Ramp–Platform
Exposed Rocky Cliff with Gravel/Sand Beach
Exposed Rocky Cliff
Shallow Subtidal Waters (≤1.8 m)
Deep Subtidal Waters (>1.8 m)
Mapping Area
Map Tile
Community
Note: When viewing the digital version of this map series in your PDF reader, scroll down to view the next map tile.
Map Tile Index
1
2
3
4
5
Iniskin Bay
COOK INLET
0 2 mi
Imagery notes: Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.
N
Feet
0 500 1,000 1,500 2,000
Meters
0 200 400 600
Scale 1:16,000
Alaska State Plane Zone 5 (units feet), 1983 North American Datum
File: 41-1-3_HabTiles_CI_PLP_EBD_v03.mxd
Date: May 20, 2011
Version: 3
Author: ABR-AZC
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1,740,000
1,745,000
2,075,000
2,070,000
2,065,000
Iniskin Bay
Back Range
See Tile 4

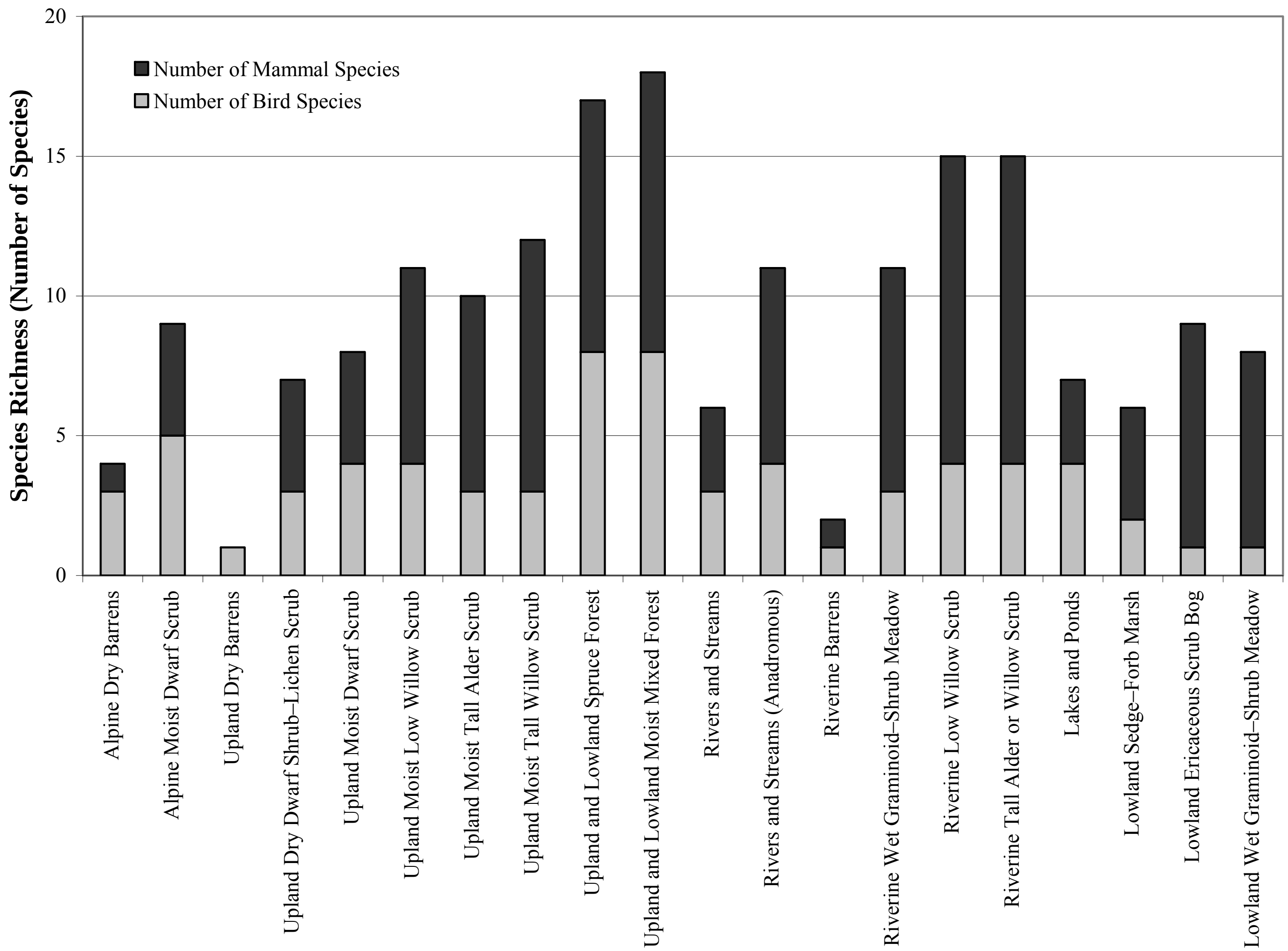

FIGURE 41.1-4
Species Richness of Bird and Mammal Species of Concern with Moderate- or High-value Habitat Rankings in Mapped Terrestrial and Freshwater Habitat Types, Cook Inlet Drainages Study Area

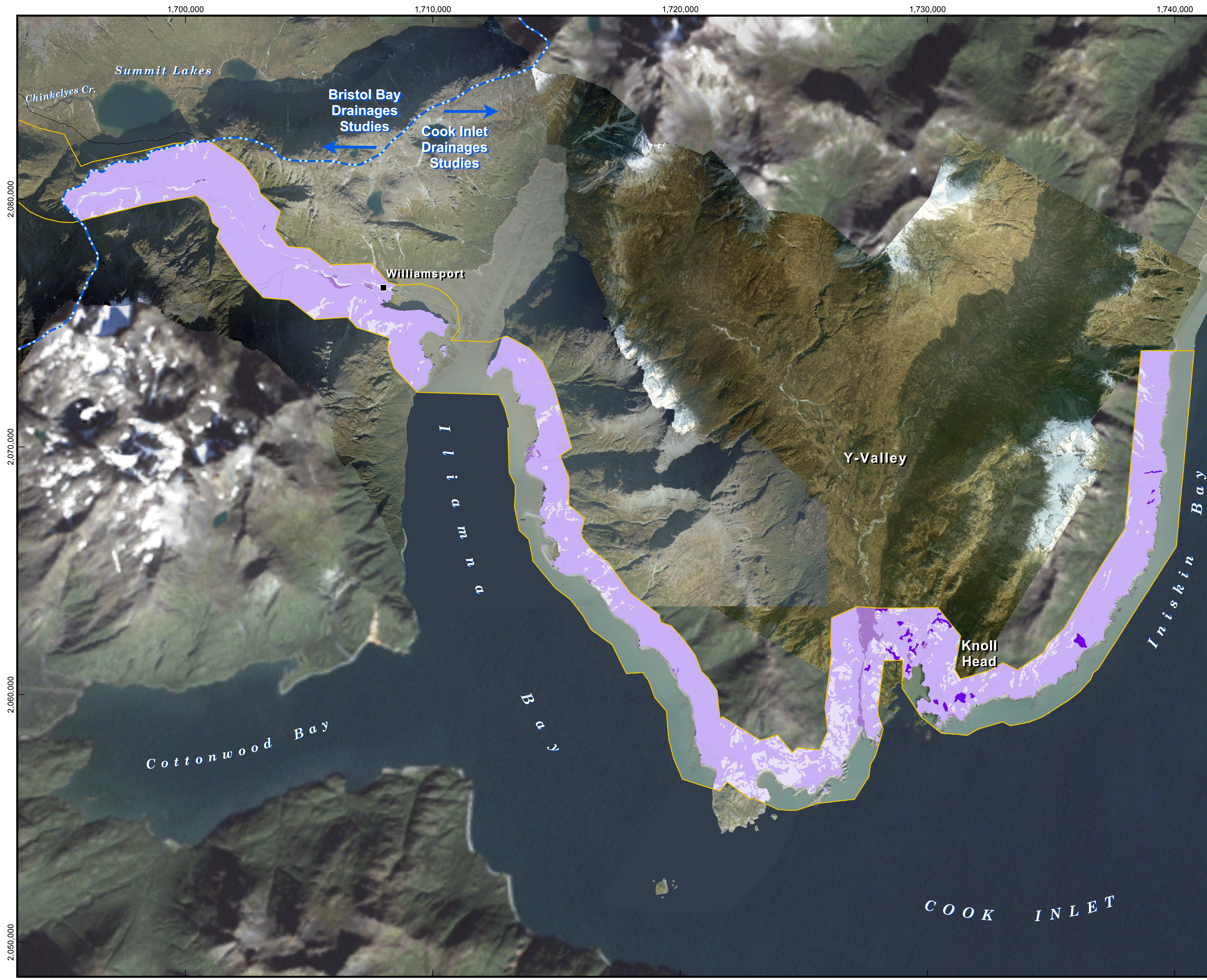

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Figure 41.1-5
Species Richness for Bird and Mammal Species of Concern in Terrestrial and Freshwater Habitats, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- High (17–18 species)
- Moderate–High (11–15 species)
- Low–Moderate (6–10 species)
- Low (1–4 species)

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the transportation-corridor mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0 0.25 0.5 0.75 1 1.25

Kilometers: 0 0.5 1 1.5 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-5_SppRichness_Terr_CI_PLP_EBD_v04.mxd	Date: May 19, 2011
Version: 4	Author: ABR-AZC

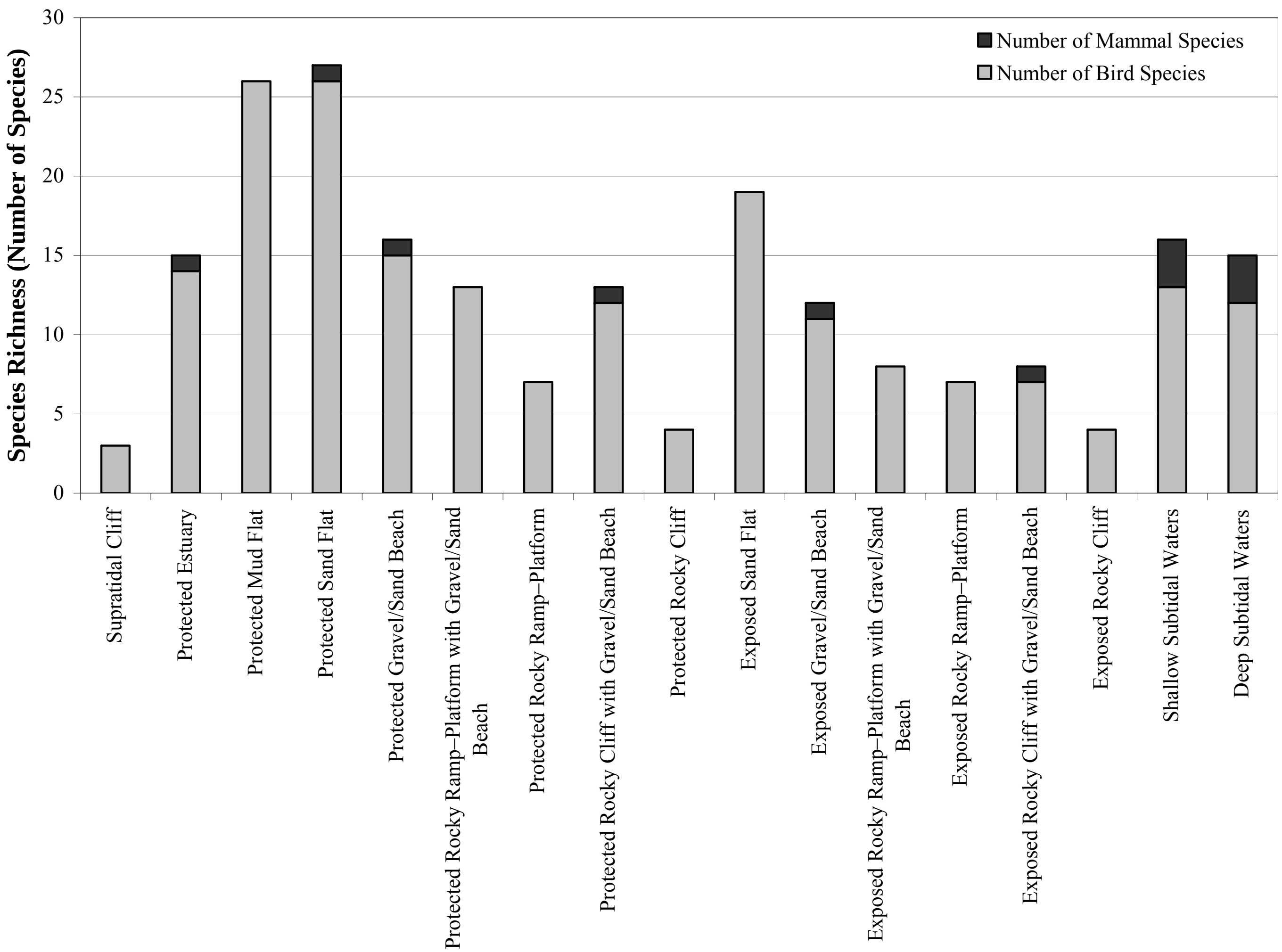

FIGURE 41.1-6
Species Richness of Bird and Mammal Species of Concern with Moderate- or High-value Habitat Rankings in Mapped Marine Habitat Types, Cook Inlet Drainages Study Area

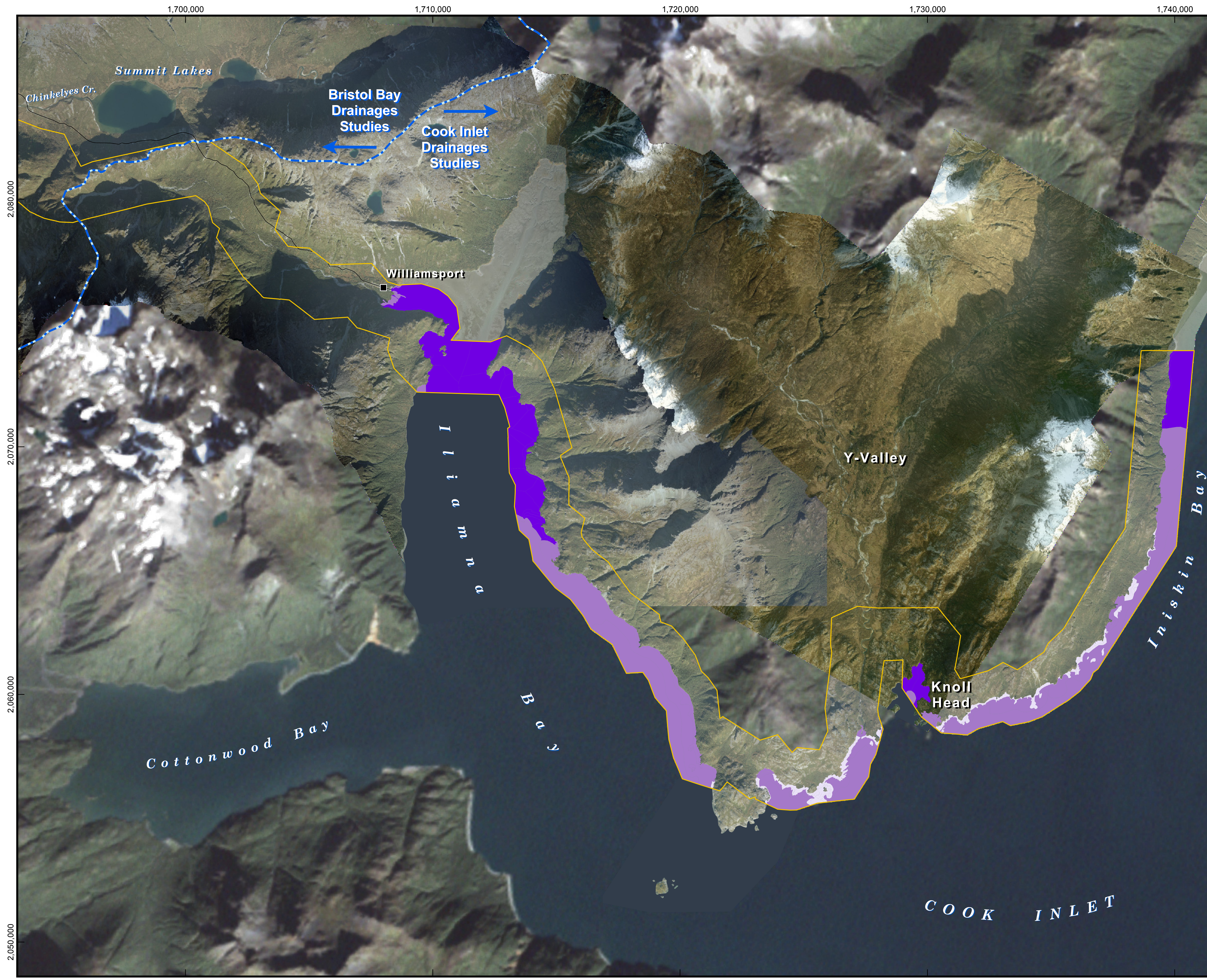

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Figure 41.1-7
Species Richness for Bird and Mammal Species of Concern in Marine Habitats, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- High (26–27 species)
- Moderate (12–19 species)
- Low (3–8 species)

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0, 0.25, 0.5, 0.75, 1, 1.25

Kilometers: 0, 0.5, 1, 1.5, 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-7_SppRichness_Marine_CI_PLP_EBD_v04.mxd	Date: May 19, 2011
Version: 4	Author: ABR-AZC

PARTNERSHIP

Figure 41.1-8 Habitat Availability for Brown and Black Bears, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- 2 Species
- 1 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0 0.25 0.5 0.75 1 1.25 1.5

Kilometers: 0 0.5 1 1.5 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

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Version: 3	Author: ABR-AZC

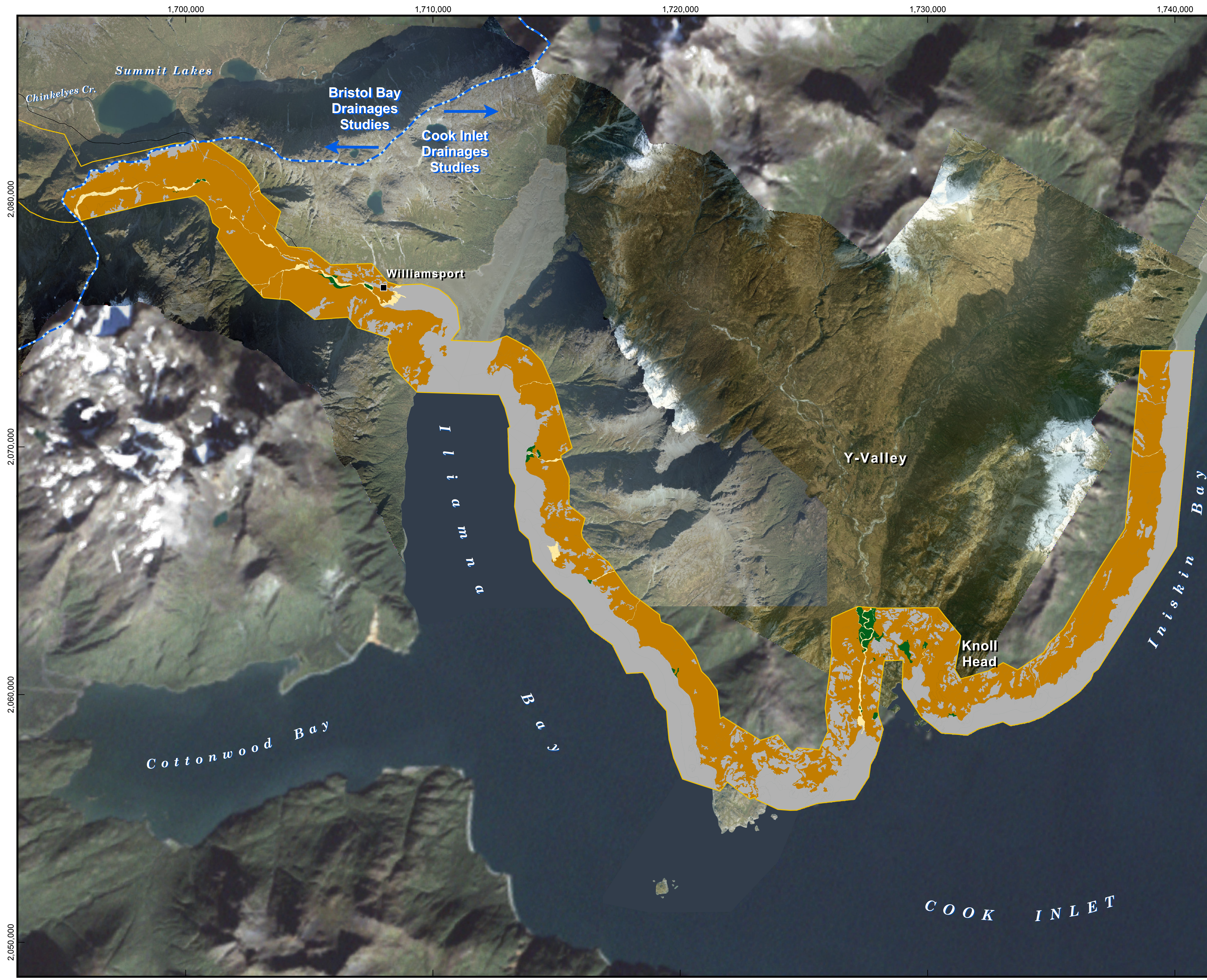

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Figure 41.1-9
Habitat Availability for Moose, Cook Inlet Drainages

Legend

Habitat Value Category for Moose

- High
- Moderate
- Low
- Negligible

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0 0.25 0.5 0.75 1 1.25 1.5

Kilometers: 0 0.5 1 1.5 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-9_Moose_HabAv_CI_PLP_EBD_v03.mxd	Date: May 19, 2011
Version: 3	Author: ABR-AZC

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Figure 41.1-10
Habitat Availability for Tree-nesting Raptor Species of Concern, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- 4 Species
- 2 Species
- 1 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0 0.25 0.5 0.75 1 1.25 1.5

Kilometers: 0 0.5 1 1.5 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-10_TreeRaptor_HabRank_CI_PLP_EBD_v04.mxd	Date: May 19, 2011
Version: 4	Author: ABR-AZC

Figure 41.1-11
Habitat Availability for Cliff-nesting Raptor Species of Concern, Cook Inlet Drainages

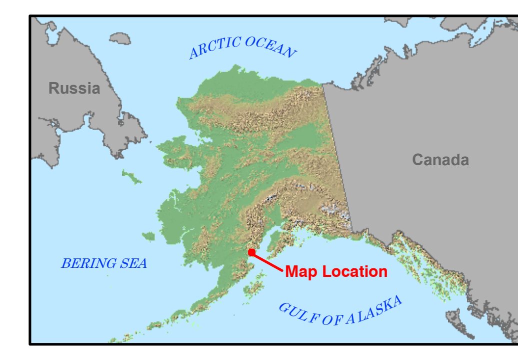
Legend

Number of Species with Moderate or High Habitat-value Rankings

- 2 Species
- 1 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.



Miles: 0 0.25 0.5 0.75 1 1.25 1.5

Kilometers: 0 0.5 1 1.5 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-11_CliffRaptor_HabAv_CI_PLP_EBD_v04.mxd	Date: May 19, 2011
Version: 4	Author: ABR-AZC

THE pebble PARTNERSHIP

Figure 41.1-12 Habitat Availability for Waterbird Species of Concern, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- 12–14 Species
- 8–10 Species
- 1–4 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5

Kilometers: 0, 0.5, 1, 1.5, 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-12_Waterbirds_HabAv_CI_PLP_EBD_v03.mxd	Date: May 19, 2011
Version: 3	Author: ABR-AZC

THE pebble PARTNERSHIP

Figure 41.1-13 Habitat Availability for Shorebird Species of Concern, Cook Inlet Drainages

Legend

Number of Species with Moderate or High Habitat-value Rankings

- 8–11 Species
- 2–4 Species
- 1 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.

Miles: 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5

Kilometers: 0, 0.5, 1, 1.5, 2

N

Scale 1:48,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-13_Shorebirds_HabAv_CI_PLP_EBD_v04.mxd	Date: May 19, 2011
Version: 4	Author: ABR-AZC

THE pebble PARTNERSHIP

Figure 41.1-14
Habitat Availability for Landbird Species of Concern, Cook Inlet Drainages

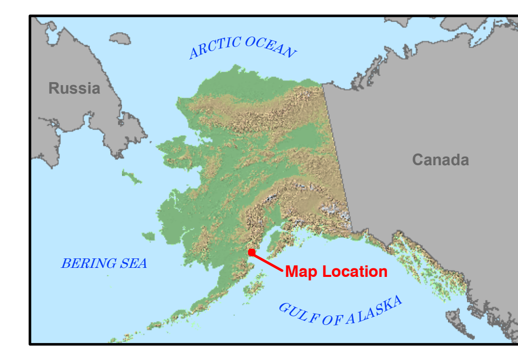
Legend

Number of Species with Moderate or High Habitat-value Rankings

- 3 Species
- 2 Species
- 1 Species
- 0 Species

- Mapping Area
- Existing Road
- Community

Digital orthomosaic for the Cook Inlet drainages mapping area from October 1, 2004 and September 28, 2008 aerial photography; ground resolution of 1.5 feet. Imagery by Aero-Metric, Inc.; additional processing by Resource Data, Inc. Background: Landsat 7 ETM+, September 6, 1999.



Miles: 0, 0.25, 0.5, 0.75, 1, 1.25, 1.5

Kilometers: 0, 0.5, 1, 1.5, 2

Scale 1:48,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-1-14_Landbirds_HabAv_CI_PLP_EBD_v03.mxd	Date: May 19, 2011
Version: 3	Author: ABR-AZC

APPENDICES

Appendix 41.1A

Average-occurrence Figures for Landbird Species of Concern in Mapped Terrestrial and Freshwater Wildlife Habitat Types, Cook Inlet Drainages Study Area, 2010

Average-occurrence Figures [a] for Landbird Species of Concern in Mapped Terrestrial and Freshwater Wildlife Habitat Types, Cook Inlet Drainages Study Area, 2010

Species	**Alpine Dry Barrens**	**Alpine Moist Dwarf Scrub**	**Upland Dry Barrens**	**Upland Dry Dwarf Shrub–Lichen Scrub**	**Upland Moist Dwarf Scrub**	**Upland Moist Low Willow Scrub**	**Upland Moist Tall Alder Scrub**	**Upland Moist Tall Willow Scrub**	**Upland and Lowland Spruce Forest**	**Upland and Lowland Moist Mixed Forest**	**Rivers and Streams**	**Rivers and Streams (Anadromous)**	**Riverine Barrens**	**Riverine Wet Graminoid–Shrub Meadow**	**Riverine Low Willow Scrub**	**Riverine Tall Alder or Willow Scrub**	**Lakes and Ponds**	**Lowland Sedge–Forb Marsh**	**Lowland Ericaceous Scrub Bog**	**Lowland Wet Graminoid–Shrub Meadow**	**Coastal Moist Barrens**	**Coastal Graminoid–Forb Meadow**	**Coastal Low Mixed Scrub**	**Nearshore Water**
	***n*=0**	***n*=0**	***n*=1**	***n*=1**	***n*=5**	***n*=3**	***n*=19**	***n*=1**	***n*=3**	***n*=3**	***n*=0**	***n*=0**	***n*=2**	***n*=0**	***n*=0**	***n*=4**	***n*=0**	***n*=0**	***n*=2**	***n*=4**	***n*=3**			
Spruce Grouse																								
Willow Ptarmigan																								
Rock Ptarmigan																								
Black-backed Woodpecker																								
Olive-sided Flycatcher																								
Gray-cheeked Thrush							**0.105**									**0.500**								
Varied Thrush																								
Blackpoll Warbler							**0.053**																	
Rusty Blackbird																								

Note:

a. Data from breeding shorebird and landbird surveys conducted in the Cook Inlet drainages study area in 2005; average occurrence = number of bird detections divided by *n* (number of point-counts conducted) (see Section 41.5 for more information). Blanks indicate no observations of that species were made during point-count surveys in that habitat.

Appendix 41.1B

Descriptions of Terrestrial and Freshwater Wildlife Habitat Types Mapped in the Cook Inlet Drainages Study Area, 2010

PHOTO 1: Alpine Dry Barrens at plot PM2043 (ABR wildlife habitat dataset), August 2005

Alpine Dry Barrens

Physiography and occurrence:	**Alpine: Uncommon in the Cook Inlet drainages study area. Occurs on ridge crests, steep upper slopes, rocky cliffs, and talus slopes.**
Vegetation structure and composition:	**Typically barren (less than 5 percent vegetation cover) or partially vegetated (5–30 percent cover) in a mosaic of barren and vegetated patches. When present, vegetation is composed of scattered dwarf shrubs (less than 0.2 meter in height), alpine cushion plants, and alpine forbs including *Empetrum nigrum, Salix arctica, Vaccinium uliginosum, Salix phlebophylla, Dryas octopetala, Diapensia lapponica,* and *Oxyria digyna*.**
Substrate and drainage:	**Rocky, extremely well-drained with little or no organic accumulation.**

PHOTO 2: Alpine Moist Dwarf Scrub at plot YV2507 (ABR wildlife habitat dataset), August 2005.

Alpine Moist Dwarf Scrub

Physiography and occurrence:	**Alpine: Uncommon in the Cook Inlet drainages study area. Concentrations of this type occur along ridge crests and upper slopes near the boundary with transportation-corridor, Bristol Bay drainages study area.**
Vegetation structure and composition:	**Vegetation structure is dominated by dwarf shrubs (less than 0.2 meter in height) and lichens. Consists of dwarf-shrub communities variously dominated by *Empetrum nigrum, Vaccinium uliginosum, Loiseleuria procumbens, Luetkea pectinata, Betula nana, Salix reticulata, Dryas octopetala,* and often trace amounts of graminoids such as *Vahlodea atropurpurea* and *Calamagrostis canadensis*. These communities often are dominated by lichens.**
Substrate and drainage:	**Rocky and well-drained with little organic accumulation.**

PHOTO 3: Upland Dry Barrens at plot YV1002 (ABR wildlife habitat dataset), June 2005.

Upland Dry Barrens

Physiography and occurrence:	**Upland: Occurs on scoured bedrock exposures, colluvium deposits, and valley-floor moraine deposits. Artificial fill is included in this type.**
Vegetation structure and composition:	**Vegetation generally absent (less than 5 percent cover). Where present, vegetation is dominated by foliose and fruticose lichens and trace amounts of dwarf ericaceous shrubs.**
Substrate and drainage:	**Unconsolidated, extremely well-drained rock and gravel.**

PHOTO 4: Upland Dry Dwarf Shrub–Lichen Scrub at plot YV1011 (ABR wildlife habitat dataset), June 2005.

Upland Dry Dwarf Shrub–Lichen Scrub

Physiography and occurrence:	**Upland: Found on relatively exposed, mid-slope sites throughout the Cook Inlet drainages study area.**
Vegetation structure and composition:	**Dwarf ericaceous shrubs (less than 0.2 meter in height) are more or less co-dominant with crustose and foliose lichens; barren patches are common. Dominant dwarf-shrub species include *Dryas octopetala, Empetrum nigrum, Betula nana*, and *Loiseleuria procumbens*. Common, co-dominant lichen species noted were *Cladina stellaris, Flavocetraria nivalis*, and *Cetraria islandica*. Forbs and graminoids occur in trace amounts**
Substrate and drainage:	**Rocky and well-drained with very little organic accumulation.**

PHOTO 5: Upland Moist Dwarf Scrub at plot PR547 (ABR wildlife habitat dataset), August 2004.

Upland Moist Dwarf Scrub

Physiography and occurrence:	**Upland: Found rarely within the Cook Inlet drainages study area on exposed colluvium or associated with Upland Dry Barrens on scoured bedrock ridges.**
Vegetation structure and composition:	**Dwarf ericaceous shrubs (less than 0.2 meter in height) are strongly dominant. Generally mesic communities variously dominated by *Empetrum nigrum, Betula nana*, or prostrate willows. Co-dominant dwarf shrubs include *Vaccinium uliginosum, Loiseleuria procumbens, Ledum decumbens*, and *Salix glauca*. Mosses and lichens are common.**
Substrate and drainage:	**Well-drained, often significant organic accumulation over rock or cobbles.**

PHOTO 6: Upland Moist Low Willow Scrub at plot YV2524 (ABR wildlife habitat dataset), August 2005.

Upland Moist Low Willow Scrub

Physiography and occurrence:	**Upland: Occurs primarily on middle and lower slope concavities.**
Vegetation structure and composition:	**Open (25–75 percent cover) to closed (greater than 75 percent cover) canopy of low willows (0.2–1.5 meters in height). Dominated by *Salix pulchra, Salix reticulata*, and *Salix richardsonii* with a largely herbaceous understory including *Equisetum arvense, Geranium erianthum,* and *Heracleum maximum*.**
Substrate and drainage:	**Poorly to moderately well-drained; moist to rarely wet loamy soils.**

PHOTO 7: Upland Moist Tall Alder Scrub at plot PR756 (ABR wildlife habitat dataset), August 2004.

Upland Moist Tall Alder Scrub

Physiography and occurrence:	**Upland: Abundant in the Cook Inlet drainages study area. Occurs primarily on glacially modified surfaces, especially low to moderately steep upper and lower slopes throughout the area. Also occasionally in lowland settings.**
Vegetation structure and composition:	**Includes open (25–75 percent cover) and closed (greater than 75 percent cover) canopies of tall alder (greater than 1.5 meters in height). Most stands are dominated by *Alnus sinuata*, but some also may have willow co-dominants and patches of low shrub. Understory species include *Salix pulchra, Dryopteris dilatata, Gymnocarpium dryopteris, Oplopanax horridus, Athyrium filix-femina, Spiraea stevenii, Rubus spectabilis*, and *Calamagrostis canadensis*.**
Substrate and drainage:	**Common soils are moderately well-drained loams.**

PHOTO 8: Upland Moist Tall Willow Scrub at plot PR712 (ABR wildlife habitat dataset), August 2004.

Upland Moist Tall Willow Scrub

Physiography and occurrence:	**Upland: Rare in the Cook Inlet drainages study area on lower slopes.**
Vegetation structure and composition:	**Includes open (25–75 percent cover) and closed (greater than 75 percent cover) canopies of tall willow (greater than 1.5 meters in height); occasionally includes patches of low willows (0.2–1.5 meters in height). Dominant willow species include *Salix pulchra, Salix richardsonii*, and *Salix barclayi*. Understory species include *Alnus sinuata, Oplopanax horridus*, and *Calamagrostis canadensis*.**
Substrate and drainage:	**Soils are moderately well-drained loams.**

PHOTO 9: Representative photograph: Upland and Lowland Spruce Forest at plot PR2013 (ABR wildlife habitat dataset), August 2005.

Upland and Lowland Spruce Forest

Physiography and occurrence:	**Upland: Occurs exclusively in upland physiographic settings in the Cook Inlet drainages study area, mostly commonly on lower slopes.**
Vegetation structure and composition:	**Generally a woodland type (less than 25 percent cover), but includes patches of open forest (25–75 percent cover) closer to the coast. Dominant tree species is *Picea glauca*. In some cases, *Betula kenaica*, *Betula occidentalis,* or *Alnus sinuata* occur as tall shrubs or small trees in woodland openings. The understory is dominated by *Ledum decumbens* and *Empetrum nigrum*. Foliose lichens such as *Cladina stellaris* may be present. This type rarely includes upland woodlands with a canopy composed either of dwarf *Picea glauca* or mature *Picea sitchensis*.**
Substrate and drainage:	**Well-developed surface organics over loam or sandy loam.**

PHOTO 10: Upland and Lowland Moist Mixed Forest at plot HDR2103 (Photo courtesy of HDR Inc.), August 2004.

Upland and Lowland Moist Mixed Forest

Physiography and occurrence:	**Upland: Rare on lower mountain slopes in the Cook Inlet drainages study area. Not present in lowland situations in this study area.**
Vegetation structure and composition:	**Upland: Includes open (25–60 percent cover) and closed (60–100 percent cover) forest types; generally dominated by *Betula kenaica,* with *Populus balsamifera, Populus trichocarpa*, and *Picea glauca* or *Picea sitchensis* as co-dominants. Common understory shrubs include *Alnus sinuata, Menziesia ferruginea, Vaccinium uliginosum, Empetrum nigrum*, and *Cornus suecica*.**
Substrate and drainage:	**Moderately well-drained; well-developed surface organics over loam or sandy loam.**

PHOTO 11: Rivers and Streams (Anadromous) at plot YV1012F (ABR avian point-count dataset), June 2005.

Rivers and Streams; Rivers and Streams (Anadromous)

Physiography and occurrence:	**Riverine: Permanently flooded river channels.**
Vegetation structure and composition:	**Stream channel morphology varies significantly throughout the Cook Inlet drainages study area. Anadromous stream designation is based on data from the Alaska *Anadromous Waters Catalog* (ADF&G, 2010), which lists the presence of salmon by stream section.**
Substrate and drainage:	**Permanently flooded channels with bottoms of unconsolidated fine sediments, gravel, cobbles, or larger rocks.**

PHOTO 12: Riverine Barrens at plot PR2026 (ABR wildlife habitat dataset), August 2005.

Riverine Barrens

Physiography and occurrence:	**Riverine: Discrete areas on point bars or interfluvial islands; typically along larger stream channels.**
Vegetation structure and composition:	**Vegetation absent or nearly so (less than 5 percent cover) or partially vegetated (5–30 percent cover).**
Substrate and drainage:	**Extremely well-drained sands and gravels.**

PHOTO 13: Riverine Wet Graminoid–Shrub Meadow at plot HDR2115 (Photo courtesy of HDR Inc.), August 2004.

Riverine Wet Graminoid–Shrub Meadow

Physiography and occurrence:	**Riverine: Bordering rivers and streams throughout the Cook Inlet drainages study area; occurs in active floodplains.**
Vegetation structure and composition:	**Strongly dominated by graminoid plants. Grass-dominated communities have extensive cover of *Calamagrostis canadensis*, but also include *Carex aquatilis, Salix pulchra, Chamerion angustifolium*, and *Equisetum arvense*. Sedge-dominated communities, often on wetter sites, include *Carex utriculata, Carex lyngbyei*, *Comarum palustre, Calmagrotis canadensis, Salix fuscescens*, and *Salix pulchra*.**
Substrate and drainage:	**Soils are wet and loamy with substantial organic accumulation.**

PHOTO 14: Riverine Low Willow Scrub at plot YV2003 (ABR wildlife habitat dataset), August 2005.

Riverine Low Willow Scrub

Physiography and occurrence:	**Riverine: Commonly occurs on interfluvial islands or flat banks within active floodplains throughout the Cook Inlet drainages study area.**
Vegetation structure and composition:	**Most occurrences of this type have an open canopy (25–75 percent cover) of low shrubs (0.2–1.5 meters in height). The most common willow species include *Salix pulchra, Salix barclayi, Salix richardsonii*, and *Salix alaxensis*. Understory species include graminoids and herbs: *Calamagrostis canadensis, Carex utriculata, Equisetum arvense*, and *Comarum palustre*. This type also includes plant communities dominated by low *Myrica gale* instead of willows; the vegetation structure is the same in the two communities.**
Substrate and drainage:	**Soils are moderately well-drained loams to sandy loams.**

PHOTO 15: Riverine Tall Alder or Willow Scrub at plot PR544 (ABR wildlife habitat dataset), August 2004.

Riverine Tall Alder or Willow Scrub

Physiography and occurrence:	**Riverine: Occurs in active floodplains throughout the Cook Inlet drainages study area.**
Vegetation structure and composition:	**Generally consists of a closed canopy (greater than 75 percent cover) of tall-shrubs (greater than 1.5 meters in height); this type rarely has 5–10 percent cover of overtopping broadleaf tree species in some sites. Most sites in the study area are dominated by alder (*Alnus sinuata*). Willow sites are dominated by *Salix alaxensis, Salix pulchra, Salix barclayi*, and *Salix richardsonii*. Other broadleaf woody species include *Populus balsamifera*, *Populus trichocarpa*, and *Betula kenaica*. Herbs commonly present are *Chamerion angustifolium, Athyrium filix-femina*, and *Artemisia tilesii*.**
Substrate and drainage:	**Soils are moderately well-drained sands and gravels, frequently found with evidence of flooding.**

PHOTO 16: Lakes and Ponds at plot PR2533 (ABR wildlife habitat dataset), August 2005.

Lakes and Ponds

Physiography and occurrence:	**Lacustrine: Kettle lakes and ponds and alpine lakes in the Cook Inlet drainages study area.**
Vegetation structure and composition:	**None.**
Substrate and drainage:	**Permanently flooded to seasonally flooded shallow waterbodies (some small ponds drain in late summer).**

PHOTO 17: Lowland Sedge–Forb Marsh at plot PR543 (ABR wildlife habitat dataset), August 2004.

Lowland Sedge–Forb Marsh

Physiography and occurrence:	**Lowland: Permanently flooded depressions found in lowland areas or along the margins of kettle lakes.**
Vegetation structure and composition:	**Herbaceous-dominated type. May be graminoid or forb-dominated with various plant communities. Common species include *Carex aquatilis, Carex rostrata, Carex utriculata, Arctophila fulva, Equisetum fluviatile, Hippuris vulgaris*, and *Menyanthes trifoliate*.**
Substrate and drainage:	**Flooded organics.**

PHOTO 18: Lowland Ericaceous Scrub Bog at plot HDR2110 (Photo courtesy of HDR Inc.), August 2005.

Lowland Ericaceous Scrub Bog

Physiography and occurrence:	**Lowland: Occurs in depressions and on low slopes throughout the Cook Inlet drainages study area; sometimes adjacent to riverine floodplains.**
Vegetation structure and composition:	**Wet communities typically dominated by ericaceous dwarf and low shrubs (less than 0.2 and 0.2–1.5 meters in height, respectively). Plant communities dominated by ericaceous shrubs or *Myrica gale*, or occasionally, these shrubs are co-dominant with sedge tussocks. Common species include *Vaccinium uliginosum, Empetrum nigrum, Ledum decumbens, Salix fuscescens, Betula nana, Myrica gale*, and *Andromeda polifolia*. Commonly occurring graminoids include *Calamagrostis canadensis, Carex aquatilis, Carex rariflora*, and *Eriophorum vaginatum*. Various *Sphagnum* moss species are common.**
Substrate and drainage:	**Organic accumulation is moderate with peat layers often occurring above rocky substrates. Surface water is common; poorly drained.**

PHOTO 19: Lowland Wet Graminoid–Shrub Meadow at plot PR541 (ABR wildlife habitat dataset), August 2004.

Lowland Wet Graminoid–Shrub Meadow

Physiography and occurrence:	**Lowland: Occurs on low-lying features such as concave toe-slopes and kettle depressions.**
Vegetation structure and composition:	**Graminoids and dwarf shrubs (less than 0.2 meter in height) are co-dominant. Common graminoid species include *Carex aquatilis, Trisetum caespitosum, Calamagrostis canadensis*, and *Eriophorum chamissonis*. Common dwarf shrubs include *Empetrum nigrum* and *Betula nana*. Associated forbs include *Eriophorum angustifolium* and *Comarum palustre*. *Sphagnum* moss species are common. Rarely included in this type are patches of more well-drained, moist meadows dominated by graminoids and dwarf shrubs.**
Substrate and drainage:	**Soils are wet to moist, with substantial organic accumulation. Surface water is generally present.**

APPENDIX 41.1C

Descriptions of Marine Wildlife Habitat Types Mapped in the Cook Inlet Drainages Study Area, 2010

Descriptions of Marine Wildlife Habitat Types Mapped in the Cook Inlet Drainages Study Area, 2010

Habitat Type [a]	Description
Subtidal Cliff	**Relatively steep bedrock cliffs and bluffs (greater than 20 degree slopes) occurring above the Mean Higher High Water (MHHW) mark. Steeper sections typically are barren bedrock, but some bluff areas primarily are composed of colluvium and can be partially vegetated with terrestrial forbs and shrubs.**
Protected Estuary	**Spans both intertidal areas (between mean lower low water [MLLW] and MHHW) and supratidal areas (above MHHW), but primarily occurs as a supratidal habitat in the study area. As described in the ShoreZone mapping program, this type is restricted to the vegetated or partially vegetated portions of estuarine areas (i.e., saltmarsh); non-vegetated estuarine areas are treated separately as mud flats or sand flats. Occurs in association with freshwater stream outlets and borders mud flats, sand flats, or sand/gravel beaches. Vegetation consists of a mosaic of wet and dry graminoid–forb communities. Commonly occurring plant species include *Elymus arenarius mollis*, *Carex lyngbyei*, *Potentilla egedii*, *Plantago major*, and *Triglochin maritimum*. Soils are sandy to clay loams. This type occurs in protected locations (wave fetch, a measure of exposure, is less than 50 kilometers). Protected Estuary occurs only in two areas (at the mouth of Williams Creek at Williamsport and at AC Point).**
Protected Mud Flat	**Occurs almost exclusively as an intertidal habitat (between MLLW and MHHW), but small occurrences of this type also are found in supratidal areas (above MHHW). Mud flats in the study area primarily are composed of glacial silt (particle sizes predominantly much less than two millimeters). Slopes are less than 5 degrees and these areas always are protected (wave fetch, a measure of exposure, is less than 50 kilometers). Protected Mud Flat primarily occurs in the upper part of Iliamna Bay.**
Protected Sand Flat	**Occurs almost exclusively as an intertidal habitat (between MLLW and MHHW), but small occurrences of this type also are found in supratidal areas (above MHHW). Like mud flats, sand flats in the study area are characterized by particle sizes less than two millimeters, but are dominant by coarser grained sands. Slopes are less than 5 degrees and this type occurs in protected locations (wave fetch, a measure of exposure, is less than 50 kilometers). Protected Sand Flat primarily occurs in the upper parts of Iliamna and Iniskin bays.**
Protected Gravel/Sand Beach	**Occurs in both intertidal areas (between mean lower MLLW and MHHW) and supratidal areas (above MHHW). Beaches in the study area are dominated by gravel, with only ten percent of substrate particles less than two millimeters in size. Slopes can be less than 5 degrees or can range from 5 to 20 degrees. This type occurs in protected locations (wave fetch, a measure of exposure, is less than 50 kilometers).**
Protected Rocky Ramp–Platform with Gravel/Sand Beach	**A hybrid of two habitat types. See descriptions for Protected Rocky Ramp–Platform and Protected Gravel/Sand Beach.**
Protected Rocky Ramp–Platform	**Occurs in both intertidal areas (between mean lower MLLW and MHHW) and supratidal areas (above MHHW). In this type, researchers combined rocky ramps (bedrock slopes between 5 and 20 degrees) and rocky platforms (bedrock shelves sloped less than 5 degrees) because the two types are used similarly by wildlife. This type occurs in protected locations (wave fetch, a measure of exposure, is less than 50 kilometers).**
Protected Rocky Cliff with Gravel/Sand Beach	**A hybrid of two habitat types. See descriptions for Protected Rocky Cliff and Protected Gravel/Sand Beach.**

Habitat Type [a]	Description
Protected Rocky Cliff	**Occurs in both intertidal areas (between mean lower MLLW and MHHW) and supratidal areas (above MHHW), but this type is more common in supratidal areas. Comprised of relatively steep bedrock cliffs (greater than 20 degree slopes). This type occurs in protected locations (wave fetch, a measure of exposure, is less than 50 kilometers).**
Exposed Sand Flat	**See description for Protected Sand Flat. This type differs in occurring in exposed locations (wave fetch, a measure of exposure, is greater than 50 kilometers). Exposed Sand Flat primarily occurs in the upper part of Iniskin Bay, directly adjacent to Protected Sand Flat.**
Exposed Gravel/Sand Beach	**See description for Protected Gravel/Sand Beach. This type differs in occurring in exposed locations (wave fetch, a measure of exposure, is greater than 50 kilometers).**
Exposed Rocky Ramp–Platform with Gravel/Sand Beach	**A hybrid of two habitat types. See descriptions for Exposed Rocky Ramp–Platform and Exposed Gravel/Sand Beach.**
Exposed Rocky Ramp–Platform	**See description for Protected Rocky Ramp–Platform. This type differs in occurring in exposed locations (wave fetch, a measure of exposure, is greater than 50 kilometers).**
Exposed Rocky Cliff with Gravel/Sand Beach	**A hybrid of two habitat types. See descriptions for Exposed Rocky Cliff and Exposed Gravel/Sand Beach.**
Exposed Rocky Cliff	**See description for Protected Rocky Cliff. This type differs in occurring in exposed locations (wave fetch, a measure of exposure, is greater than 50 kilometers).**
Shallow Subtidal Waters	**Shallow waters (0 to 1.8 meters deep at low tide) in the nearshore area, occurring below the MLLW mark. These waters occur closest to the shoreline.**
Deep Subtidal Waters	**Deep waters (1.8 to 36.7 meters deep at low tide) in the nearshore area, occurring below the MLLW mark and offshore of Shallow Subtidal Waters.**

Notes:

a. Habitat types were mapped using publicly available bathymetry and shoreline mapping data from the National Oceanic and Atmospheric Administration (NOAA, 2010a; b; see methods text in Section 41.1.6.3).

Appendix 41.1D

Wildlife Habitat Values for a Selected Set of Bird and Mammal Species of Concern in Terrestrial and Freshwater Habitat Types, Cook Inlet Drainages Study Area, 2010

Wildlife Habitat Values for a Selected Set of Bird and Mammal Species of Concern in Terrestrial and Freshwater Habitat Types, Cook Inlet Drainages Study Area, 2010 [a,b]

Species	Alpine Dry Barrens	Alpine Moist Dwarf Scrub	Upland Dry Barrens	Upland Dry Dwarf Shrub–Lichen Scrub	Upland Moist Dwarf Scrub	Upland Moist Low Willow Scrub	Upland Moist Tall Alder Scrub	Upland Moist Tall Willow Scrub	Upland and Lowland Spruce Forest	Upland and Lowland Moist Mixed Forest	Rivers and Streams	Rivers and Streams (Anadromous)	Riverine Barrens	Riverine Wet Graminoid–Shrub Meadow	Riverine Low Willow Scrub	Riverine Tall Alder or Willow Scrub	Lakes and Ponds	Lowland Sedge–Forb Marsh	Lowland Ericaceous Scrub Bog	Lowland Wet Graminoid–Shrub Meadow
Birds																				
Trumpeter Swan	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	2	1	1	1
Harlequin Duck	0	0	0	0	0	0	0	0	0	0	1	3	1	3	3	3	0	*1*	*1*	*1*
Spruce Grouse	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
Willow Ptarmigan	0	2	0	0	2	2	2	2	0	0	0	0	0	1	1	1	0	0	1	1
Rock Ptarmigan	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bald Eagle	*0*	*1*	*1*	*1*	*1*	*1*	0	0	3	2	2	3	1	1	1	1	2	2	1	1
Northern Goshawk	0	0	0	0	*1*	*1*	0	0	2	2	0	0	0	0	1	1	0	0	1	1
Golden Eagle	3[c]	2	2	2	2	2	1	1	1	1	2[c]	1	1	1	1	0	1	1	1	1
Merlin	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	2	1	1	1
Gyrfalcon	1	1	1	1	1	1	0	0	1	1	*0*	*0*	1	1	0	0	0	0	0	0
Peregrine Falcon	1	1	1	2	2	2	1	1	2	2	2[c]	2[c]	2	2	2	1	2	2	2	2
American Golden-Plover	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Solitary Sandpiper	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	1	1	1	0
Lesser Yellowlegs	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	1	1	1
Whimbrel	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1
Hudsonian Godwit	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1
Surfbird	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short-billed Dowitcher	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1
Arctic Tern	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Great Horned Owl	0	0	0	0	1	1	0	0	2	2	1	1	1	*2*	*2*	*2*	1	0	1	*1*
Black-backed Woodpecker	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Olive-sided Flycatcher	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	1	0
Gray-cheeked Thrush	0	0	0	0	0	2	3	3	1	0	0	0	0	0	2	3	0	0	0	0
Varied Thrush	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
Blackpoll Warbler	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	2	0	0	1	0
Rusty Blackbird	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	0

Species	Alpine Dry Barrens	Alpine Moist Dwarf Scrub	Upland Dry Barrens	Upland Dry Dwarf Shrub–Lichen Scrub	Upland Moist Dwarf Scrub	Upland Moist Low Willow Scrub	Upland Moist Tall Alder Scrub	Upland Moist Tall Willow Scrub	Upland and Lowland Spruce Forest	Upland and Lowland Moist Mixed Forest	Rivers and Streams	Rivers and Streams (Anadromous)	Riverine Barrens	Riverine Wet Graminoid–Shrub Meadow	Riverine Low Willow Scrub	Riverine Tall Alder or Willow Scrub	Lakes and Ponds	Lowland Sedge–Forb Marsh	Lowland Ericaceous Scrub Bog	Lowland Wet Graminoid–Shrub Meadow
Mammals																				
Wolf	1	2	1	2	2	2	1	2	2	2	1	2	1	2	2	2	1	1	2	2
Red fox	1	1	1	1	1	2	1	2	2	2	1	2	1	2	2	2	1	1	2	2
River otter	0	0	0	0	0	0	0	0	0	0	3	3	2	2	2	2	3	1	1	1
Wolverine	1	2	1	2	2	2	2	2	2	2	1	2	1	2	2	2	1	1	2	2
Black bear	0	0	0	0	0	1	3	2	2	3	1	2	1	2	2	3	1	2	2	2
Brown bear	1	2	1	2	2	2	2	2	2	2	2	3	1	2	2	2	1	2	2	2
Moose	0	0	0	0	0	1	2	3	2	2	1	1	1	2	3	3	3	2	2	2
Arctic ground squirrel	2	2	1	3	2	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
Red squirrel	0	0	0	0	0	0	*1*	0	3	3	0	0	0	0	0	*1*	0	0	0	0
Beaver	0	0	0	0	0	0	1	1	0	2	3	3	1	1	2	2	3	0	0	0
Northern red-backed vole	0	1	0	1	1	2	2	2	3	3	0	0	0	1	2	2	0	1	2	1
Tundra vole	0	1	0	0	1	2	2	2	1	1	0	0	0	3	2	2	0	2	2	3
Snowshoe hare	0	0	0	0	1	2	2	2	3	2	0	0	0	0	2	3	0	0	1	0

Notes:

a. See Methods text (Section 41.1.6.3) and Table 41.1-1 for information on how these species were selected.

b. Key to habitat-value codes: 3 = high, 2 = moderate, 1 = low, 0 = negligible; data quality indicated by font type as data-supported from project-specific data and scientific literature (bold), partially data-supported from literature only (regular), and professional judgment (italic).

c. Nesting by these raptor species can occur in these habitats only in areas where suitable cliffs occur.

APPENDIX 41.1E

Wildlife Habitat Values for a Selected Set of Bird and Mammal Species of Concern in Marine Habitat Types, Cook Inlet Drainages Study Area, 2010

Wildlife Habitat Values for a Selected Set of Bird and Mammal Species of Concern in Marine Habitat Types, Cook Inlet Drainages Study Area, 2010 [a, b]

Species	Supratidal Cliff	Protected Estuary	Protected Mud Flat	Protected Sand Flat	Protected Gravel/Sand Beach	Protected Rocky Ramp–Platform with Gravel/Sand Beach	Protected Rocky Ramp–Platform	Protected Rocky Cliff with Gravel/Sand Beach	Protected Rocky Cliff	Exposed Sand Flat	Exposed Gravel/Sand Beach	Exposed Rocky Ramp–Platform with Gravel/Sand Beach	Exposed Rocky Ramp–Platform	Exposed Rocky Cliff with Gravel/Sand Beach	Exposed Rocky Cliff	Shallow Subtidal Waters	Deep Subtidal Waters
Birds																	
American Wigeon	0	3	3	2	2	1	0	1	0	1	1	0	0	0	0	1	0
Mallard	0	3	3	2	2	1	0	1	0	1	1	1	0	1	0	1	0
Northern Pintail	0	3	3	2	2	1	0	1	0	1	1	0	0	0	0	1	0
Green-winged Teal	0	3	3	2	2	1	0	1	0	1	1	1	0	1	0	1	0
Greater Scaup	0	0	3	3	3	1	0	1	0	3	2	1	0	1	0	3	3
Steller's Eider	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Harlequin Duck	0	0	3	3	3	3	3	3	1	3	3	3	3	3	1	3	3
Surf Scoter	0	0	3	3	3	2	0	2	0	3	2	1	0	1	0	3	3
Black Scoter	0	0	3	3	3	2	0	2	0	3	2	1	0	1	0	3	3
Long-tailed Duck	0	0	3	3	3	2	0	2	0	2	2	1	0	1	0	3	3
Red-throated Loon	0	0	3	3	3	2	0	2	0	2	2	1	0	1	0	3	3
Horned Grebe	0	0	3	3	3	2	0	2	0	2	2	1	0	1	0	3	3
Red-faced Cormorant	0	0	0	1	2	3	3	3	2	1	2	3	3	3	2	3	3
Pelagic Cormorant	0	0	0	1	2	3	3	3	2	1	2	3	3	3	2	3	3
Bald Eagle	2	2	2	2	1	1	1	2	2	1	1	1	1	2	2	2	2
Golden Eagle	2	1	1	1	1	0	0	1	1	1	1	0	0	1	1	0	0
Merlin	1	1	2	2	1	1	1	1	1	1	1	0	0	0	0	2	0
Peregrine Falcon	3	2	2	2	1	1	1	3	3	1	1	1	1	3	3	2	2
American Golden-Plover	0	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0

Species	Supratidal Cliff	Protected Estuary	Protected Mud Flat	Protected Sand Flat	Protected Gravel/Sand Beach	Protected Rocky Ramp–Platform with Gravel/Sand Beach	Protected Rocky Ramp–Platform	Protected Rocky Cliff with Gravel/Sand Beach	Protected Rocky Cliff	Exposed Sand Flat	Exposed Gravel/Sand Beach	Exposed Rocky Ramp–Platform with Gravel/Sand Beach	Exposed Rocky Ramp–Platform	Exposed Rocky Cliff with Gravel/Sand Beach	Exposed Rocky Cliff	Shallow Subtidal Waters	Deep Subtidal Waters
Black Oystercatcher	0	0	2	2	3	3	3	3	0	2	3	3	3	3	0	0	0
Solitary Sandpiper	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Lesser Yellowlegs	0	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Whimbrel	0	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Hudsonian Godwit	0	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Marbled Godwit	0	3	3	3	0	0	0	0	0	3	0	0	0	0	0	0	0
Black Turnstone	0	2	2	2	1	3	3	1	0	2	1	3	3	1	0	0	0
Surfbird	0	1	2	2	1	3	3	1	0	2	1	3	3	1	0	0	0
Rock Sandpiper	0	1	3	3	0	3	3	0	0	3	0	3	3	0	0	0	0
Dunlin	0	3	3	3	0	0	0	0	0	3	0	0	0	0	0	0	0
Short-billed Dowitcher	0	2	2	2	0	0	0	0	0	2	0	0	0	0	0	0	0
Marbled Murrelet	0	0	2	3	3	3	0	3	0	2	2	3	0	3	0	3	3
Mammals																	
Wolf	0	1	0	0	1	1	0	1	0	0	1	1	0	1	0	0	0
Red fox	0	1	0	0	1	1	0	1	0	0	1	1	0	1	0	0	0
Sea otter	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	2	2
River otter	0	1	0	0	1	1	1	1	0	0	1	1	1	1	0	2	1
Wolverine	0	1	0	0	1	1	0	1	0	0	1	1	0	1	0	0	0
Harbor seal	0	0	1	2	0	0	0	0	0	1	0	0	0	0	0	3	3
Black bear	0	1	0	0	1	1	1	1	0	0	1	1	1	1	0	0	0
Brown bear	0	2	1	1	2	1	1	2	0	1	2	1	1	2	0	0	0

Species	**Supratidal Cliff**	**Protected Estuary**	**Protected Mud Flat**	**Protected Sand Flat**	**Protected Gravel/Sand Beach**	**Protected Rocky Ramp–Platform with Gravel/Sand Beach**	**Protected Rocky Ramp–Platform**	**Protected Rocky Cliff with Gravel/Sand Beach**	**Protected Rocky Cliff**	**Exposed Sand Flat**	**Exposed Gravel/Sand Beach**	**Exposed Rocky Ramp–Platform with Gravel/Sand Beach**	**Exposed Rocky Ramp–Platform**	**Exposed Rocky Cliff with Gravel/Sand Beach**	**Exposed Rocky Cliff**	**Shallow Subtidal Waters**	**Deep Subtidal Waters**
Harbor porpoise	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1	2
Moose	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Northern red-backed vole	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Tundra vole	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Notes:

a. See Methods text (Section 41.1.6.3) and Table 41.1-1 for information on how these species were selected.

b. Key to habitat-value codes: 3 = high, 2 = moderate, 1 = low, 0 = negligible; data quality indicated by font type as data-supported from project-specific data and scientific literature (bold), partially data-supported from literature only (regular), and professional judgment (italic).

41.2 Mammals

41.2.1 Introduction

Based on historical reports (Osgood, 1904; Schiller and Rausch, 1956; Cahalane, 1959) and recent field inventories (Cook and MacDonald, 2004a, 2004b; Jacobsen, 2004), up to 40 species of mammals are known (or strongly suspected) to occur in the geographic region containing the Cook Inlet drainages study area (see list of species in Chapter 16, Appendix 16.2A).

The study area is at the eastern end of the annual range of the Mulchatna Caribou Herd (MCH), one of the larger herds of caribou in the state. Other species of large mammals are ecologically and economically important inhabitants of the region. Brown bears are abundant in southwestern Alaska, whereas black bears are present in lower densities. Moose occur throughout the region in low densities. These species were of primary interest for field surveys, but all mammal species encountered incidentally, such as gray wolf and other furbearers, were recorded. Another source of mammal observations was incidental sightings during surveys of waterfowl, raptors, and breeding birds. No surveys were conducted specifically for small mammals because of the availability of results from recent inventory work conducted in Lake Clark and Katmai national parks and preserves for the National Park Service (NPS; Cook and MacDonald, 2004a, 2004b) and in the area northwest of Iliamna Lake and in the Kvichak and Nushagak river drainages for the Bureau of Land Management (BLM; Jacobsen, 2004).

This discussion summarizes findings of the 2004 and 2005 terrestrial mammal studies in the study area and supplements that information with additional observations from 2006 and 2007.

41.2.2 Study Objective

The study objective established for the terrestrial mammal surveys in the Cook Inlet drainages study area was to characterize the distribution and abundance of caribou, brown bears, moose, and other species of large mammals in the study area at various biologically important times of the year, including estimation for the population densities of bears and moose.

41.2.3 Study Area

In 2004 and 2005, reconnaissance surveys were flown in the Cook Inlet drainages study area (Figure 41.2-1). The surveys in 2004 focused on selected corridors between the Cook Inlet shoreline and the divide between the Cook Inlet drainages and the adjoining transportation-corridor study area in the Bristol Bay drainages (described in Section 16.7). The survey area for mammals was modified in 2005 (Figure 41.2-1) to include the “Y Valley” on the northern side of Iliamna Bay and a corridor across the center of the Iniskin Peninsula. No reconnaissance surveys for terrestrial mammals were flown in 2006 and 2007, but incidental sightings of mammals were recorded during the marine wildlife surveys described in Chapter 44.

A survey was conducted in August 2004 along salmon-spawning streams in the study area (Figure 41.2-1). The stream-survey area was chosen to enumerate brown bears during a time of year when many bears congregate along streams with runs of anadromous fishes.

The study area in the Cook Inlet drainages lies within a single Game Management Unit, GMU 9A.

41.2.4 Previous Studies

Most of the available information on mammal distribution and abundance in the study area comes from studies done by or for government resource agencies, such as Alaska Department of Fish and Game (ADF&G) surveys and inventory studies (e.g., ADF&G, 1985; Becker, 2001, 2003; Butler, 2004, 2005; Woolington, 2005) and NPS studies (e.g., Bennett, 1996; Putera, 2006; Olson and Putera, 2007; and unpublished file reports at Lake Clark National Park and Preserve). Under an agreement with Cominco Exploration (Cominco), ADF&G surveys in the early 1990s (summarized by Boudreau et al., 1992; Van Daele and Boudreau, 1992; Van Daele, 1994) focused mostly on the area of the Pebble Deposit, but also covered parts of the transportation-corridor study areas. Some other surveys (Smith, 1991) were conducted for Cominco at that time, when the Pebble Deposit was first being evaluated. Notable studies in the region in recent years were conducted as part of broad-scale species-inventory efforts by NPS and BLM emphasizing small mammals (Cook and MacDonald, 2004a, 2004b; Jacobsen, 2004); the latter study for BLM included several field sites in and near the transportation-corridor study area, although none of the study sites were in the Cook Inlet drainages.

41.2.5 Scope of Work

Field surveys were conducted periodically during April through November 2004 and March through December 2005. The mammal study was conducted by Brian Lawhead and Alexander Prichard, supported by other biologists from ABR, Inc. Local-knowledge observers Carl Jensen of Pedro Bay and James Lamont of Newhalen participated in surveys in August and October 2004 and in May 2005. The study was conducted according to the approach described in the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and in the *Draft Environmental Baseline Studies, 2005 Study Plans* (NDM, 2005) (Appendix E).

The aerial surveys were designed to obtain information on the distribution, relative abundance, and general patterns of use of the study area by large mammals, rather than to derive detailed population estimates. Such population estimation is conducted by ADF&G and requires substantially greater survey effort over larger areas for a meaningful population estimate. Thus, the Pebble surveys complement, rather than duplicate, ADF&G population surveys.

Specific work elements in 2004 and 2005 included the following tasks:

- Collection and review of relevant literature on all species of mammals inhabiting the project region.
- Aerial reconnaissance surveys of the Cook Inlet drainages study area during late winter, caribou calving, caribou postcalving, caribou rut/fall migration, and early winter.
- Aerial survey of brown bears along salmon-spawning streams, and examination of reported dens of brown bears.
- Acquisition and analysis of radio-telemetry data for the MCH.
- Development of a wildlife-sighting log for the documentation of wildlife observations by other personnel working on the Pebble Project.

- Collection of information on mammal observations made incidentally by other Pebble Project personnel working in the study area.

41.2.6 Methods

41.2.6.1 Reconnaissance Surveys

In both 2004 and 2005, reconnaissance surveys were flown in a fixed-wing airplane (Cessna 206) along designated survey corridors within the study area (Figure 41.2-1). Two observers searched for mammals on opposite sides of the aircraft, viewing as far out to the side as vegetation allowed (in practice, 400 to 800 meters). For all surveys, the airplane was flown at an airspeed of approximately 140 kilometers per hour and an altitude of 150 meters above ground level (occasionally higher or lower as dictated by terrain). The coordinates of mammal locations were recorded using global positioning system (GPS) receivers. The data collected for each sighting included species, number of animals, sex and age composition (when possible), activity, and direction of movement.

Additional observations of bears were recorded incidentally during other wildlife surveys in all four years (2004 through 2007), principally during surveys for harbor seals (Chapter 44) and waterbirds (Section 41.4) in the coastal bays within the study area. The fixed-wing airplane surveys for harbor seals in 2007 covered areas such as the heads of Iniskin and Chinitna bays, where concentrations of bears had been noted in 2004 and 2005. Terrestrial mammals also were recorded during transits on the Iniskin Peninsula while the harbor seal survey crew moved between Iniskin and Chinitna bays.

41.2.6.2 Stream and Den Surveys

A bear survey along salmon-spawning streams was conducted in mid-August 2004 using a turbine helicopter (Hughes 500D). Streams mapped by ADF&G (2004) as providing spawning habitat for salmon were preselected for the survey, and additional streams were added on the recommendation of local-knowledge observer Carl Jensen or if spawning salmon were seen during the survey. Two observers searched on the right side of the helicopter and one observer and the pilot searched on the left side. Flight altitude varied depending on topography, but was usually 60 to 90 meters above ground level. Location coordinates of bears and other mammals were recorded using GPS receivers. The data collected for each sighting included species, number of animals, sex and age composition (when possible), activity, and direction of movement.

In place of a bear survey along spawning streams in summer 2005, bear observations were tallied during surveys for Harlequin Ducks (Section 41.4) to reduce helicopter overflights.

Ground visits at several prospective bear dens in the study area were conducted on August 20, 2004, and on August 30, 2005.

41.2.7 Results and Discussion

In 2004, aerial reconnaissance surveys in the Cook Inlet drainages were conducted from a fixed-wing airplane on April 12, May 21, June 30, October 20, and November 30, and the stream survey was flown by helicopter on August 20 (Table 41.2-1). In 2005, aerial reconnaissance surveys for mammals were conducted on May 10 and 11, May 25 and 26, June 28 and 29, August 30 (helicopter), October 10, and

December 13. Incidental observations of large mammals also were recorded on aerial surveys for waterfowl and raptors during April/May and September/October 2004 and from April through December 2005. Additional observations were recorded during aerial surveys for harbor seals in Iliamna, Iniskin, and Chinitna bays conducted between April and December 2005 and between May and October 2007, as well as during helicopter surveys for marine wildlife in 2006 and 2007 (described in Chapter 44).

The detectability (sightability) of mammals in the study area generally was low because of thick vegetation. Sightability was very low in the closed-canopy stands of shrubs lining the streams and slopes of the coastal bays, but was better in the higher tundra portions of the survey area and in coastal sedge meadows. Detectability was not quantified in the study area because of the practical constraints imposed by surveying narrow alignments in steep terrain.

41.2.7.1 Bears

Although both black and brown bears were present in the survey area, brown bears were more numerous. A rigorous population survey (more than 13,636 kilometers surveyed on 683 transects covering 7,380 square kilometers [km²]) in GMU 9A during May 2003 and 2004 resulted in estimated densities of 150 brown bears and 85 black bears per 1,000 km² (Olson and Putera, 2007). That survey produced sightings of 279 groups totaling 472 brown bears and 213 groups totaling 268 black bears. All but two of the black-bear sightings were in the area north and east of Iniskin Bay, including the Iniskin Peninsula (Olson and Putera, 2007).

During the Pebble Project surveys, brown bears were frequently seen along the coastline and were most numerous at the heads of Iniskin and Chinitna bays (Figure 41.2-2). Black bears were occasionally seen along the coastline, but were observed most frequently along the survey corridor on the Iniskin Peninsula between Iniskin and Chinitna bays. Black bears spend more time in forested areas, where visibility is low due to thick vegetation (Bennett, 1996).

No bear dens were confirmed in the study area; several reported dens were examined but were determined not to be bear dens. The extensive alder thickets made den sites difficult to locate, so a comprehensive survey for dens was not attempted.

In southwestern Alaska, brown bears are known to congregate in coastal areas with abundant food, for example, salt marshes, sedge meadows, salmon-spawning streams, and intertidal clam beds (Bennett, 1996; Smith and Partridge, 2004; Rode et al. 2006a, 2006b; Putera, 2006). Coastal meadows in early summer contain high-protein, highly digestible sedges and grasses that attract bears (Smith and Partridge, 2004; Putera, 2006). Bennett (1996) reported that bears in salt marshes in Lake Clark National Park and Preserve fed primarily on alkali grass (*Puccinellia phryganodes*), Raminski sedge (*Carex raminskii*), little arrowgrass (*Triglochin palustre*), and big arrowgrass (*T. maritimum*).

Large aggregations of brown bears were seen repeatedly in the sedge meadows and mudflats at the heads of Iniskin and Chinitna bays during the spring and summer each year, with the highest counts occurring in June (Figure 41.2-2, Tables 41.2-1). (Bear observations made during harbor seal surveys are shown on Figure 41.2-2 as part of the large mammal surveys.) The largest number of bears observed on the mammal surveys in 2004 was on June 30, when 38 brown bears were seen, 36 of which were concentrated in the sedge/grass meadows at the head of Iniskin Bay. A similar number of bears (33 in view at one time) were observed in the same area by the boat-based, marine wildlife survey in June 2004.

The largest number of bears observed on a single day in 2005 was 61, observed during a harbor seal survey on May 31; 46 of those bears were at the head of Iniskin Bay. The maximal number counted among all four years occurred on June 20, 2007, when 92 brown bears were counted along a 4.5-mile stretch of sedge/grass meadows at the head of Iniskin Bay. When bears were so numerous, it was not possible to accurately map the locations of all groups seen during the surveys. The density of brown bears was higher at the head of Iniskin Bay than in the surveyed portion of Chinitna Bay, but bears were numerous in the latter area as well.

Detectability of bears was high in open sedge/grass meadows, but very low in adjacent thick vegetation. Bennett (1996) estimated that only 29 percent of bears using coastal salt marshes were detected during his aerial surveys, because of movement of bears into dense vegetation nearby.

The Pebble Project surveys demonstrate that a large number of brown bears congregate to feed in sedge/grass meadows in upper Iniskin Bay during early summer, similar to the situation reported in Chinitna Bay in Lake Clark National Park and Preserve (Bennett, 1996), at the northern edge of the study area. According to Bennett (1996), Glacier Spit Marsh in Chinitna Bay had an estimated density of 7.1 bears/km^2, but densities over the entire Cook Inlet drainages study area would be much lower.

Bennett (1996) also found that the number of bears using coastal salt marshes peaked in late June and early July, but timing varied between boars and sows. Adult boars were found in the salt marshes primarily during the mating season in early June, and sows with cubs often did not appear until early July. The number of all brown bears seen in that study declined rapidly in August. In the Pebble surveys, bear numbers declined after June, but bears were seen regularly throughout the summer and shifted to salmon-spawning streams later in July and August.

There was little evidence that bears dug for clams in this area, as has been observed in Katmai National Park and Preserve, southern Kamishak Bay, and to a lesser extent, Chinitna Bay (Smith and Partridge, 2004; Starkes, pers. comm., 2007). No such behavior was observed during the Pebble mammal surveys. Only one observation was made of a brown bear foraging for clams—during a minus tide on May 17, 2006, in the intertidal mudflat of outer Iniskin Bay by the survey crew working on the Pebble marine invertebrate study (Starkes, pers. comm., 2007).

Brown bears move to streams in mid- to late summer and fall as spawning salmon of various species arrive. Salmon in the diet has a strong positive effect on bear body size, productivity, and bear density (Hilderbrand et al., 1999). Researchers observed bears along salmon streams, including the Iniskin River and Portage Creek in Iniskin Bay and the stream in the Y Valley between Iliamna and Iniskin Bay; the pool at the mouth of the stream in the Y Valley was a productive fishing location for bears. Bear trails, indicating repeated use by brown bears, were observed along the edges of Iniskin Bay near Knoll Head, as well as crossing the ridge at the head of the Y Valley.

Alternate-year hunting seasons have been in effect in GMU 9A since the mid-1970s. Between 33 and 54 brown bears were harvested annually in odd-numbered years during 1991 through 2005 (mean = 39 per year; Schwartz, pers. comm., 2006). Black bear harvests were low, ranging from one to six bears per year, in the coastal area from Bruin Bay in the south to Chinitna Bay in the north. Bear-hunter camps, boats, and several carcasses of harvested bears were seen in Iniskin and Cottonwood bays during aerial surveys in fall 2005.

41.2.7.2 Other Mammals

Moose

ADF&G estimated that 300 moose occurred in all of GMU 9A in 2002, for a mean density of 0.05 moose/km² (Butler, 2004). Suitable habitat for moose in the Cook Inlet drainages study area was restricted mostly to the Y Valley between Iliamna and Iniskin bays and on the Iniskin Peninsula between Iniskin and Chinitna bays.

Aerial surveys conducted for the Pebble Project detected few moose in the survey area; most of those seen were on the Iniskin Peninsula. Only one moose was seen in 2004, a cow in the Y Valley in November (Table 41.2-1; Figure 41.2-3). Eleven moose were seen in the study area during mammal surveys in 2005, and three others were seen incidentally during other wildlife surveys that year (Tables 41.2-1 and 41.2-2; Figure 41.2-3). No moose were seen during the few wildlife surveys flown in 2006. One was seen during a mammal survey in June 2007, and 21 were seen incidentally during marine wildlife surveys in May and October of that year (Tables 41.2-1 and 41.2-2; Figure 41.2-3).

Harvests of moose were extremely low in these coastal areas (one to four annually during 1991 through 2005 in the coastal area from Bruin Bay in the south to Chinitna Bay in the north; Schwartz, pers. comm., 2006).

Caribou

No caribou were observed in the study area during wildlife surveys in 2004 or 2005. This area is almost completely out of the range of the Mulchatna Caribou Herd, and the steep coastal mountains and intertidal areas that dominate this area are not preferred caribou habitats. Out of the 29 years of MCH telemetry data analyzed for the Pebble studies (described in Section 16.2), only one radio-collared caribou was found in the study area. That caribou was found by ADF&G on the central Iniskin Peninsula on December 9, 1983. Because caribou were not expected in the study area, it is likely that most caribou-survey flights did not extend that far; however, no satellite-tracked caribou were recorded in the study area either. The next closest caribou location was approximately 27 kilometers inland from the coast.

As would be expected in the extreme eastern end of the range of the MCH, harvests of caribou in the area of GMU 9A between Bruin and Chinitna bays were low—one in the 1998/1999 regulatory year and six each in 1999/2000 and 2003/2004 (Schwartz, pers. comm., 2006).

Other Species

Red foxes were observed occasionally at the head of Iniskin and Iliamna bays in 2004 and 2005 (Tables 41.2-1 and 41.2-2; Figure 41.2-3). River otters were recorded incidentally in several locations in or near Iniskin and Iliamna bays on other wildlife surveys in 2004, 2005, and 2006 (Table 41.2-2; Figure 41.2-3). No wolves or wolverines were observed during aerial surveys in the study area, although both species were observed nearby in the Iliamna River drainage (Figure 41.2-3).

Few furbearers were taken by trappers in the coastal area of GMU 9A between Bruin and Chinitna bays from 1990 through 2005 (based on ADF&G sealing records; Schwartz, pers. comm., 2006):

- Nine beavers in 1996.
- One lynx each year in 1994 and 1997.
- One marten in 2002.
- Eight river otters in 1996.
- Two wolves in 2000 and one in 2005.
- Between one and five wolverines annually during 1991-1996 and 2001-2003.

41.2.8 Summary

The distribution and abundance of large mammals in the Cook Inlet drainages study area were evaluated during aerial reconnaissance surveys using fixed-wing aircraft in April, May, June, October, and November 2004 and in March, May, June, October, and December 2005. In addition, bear use of salmon-spawning streams was surveyed in August 2004, and a brief survey of reported bear dens was conducted in August 2005. Incidental observations of large mammals also were recorded during other wildlife surveys, most notably during aerial surveys of harbor seal haul-outs in the coastal bays in 2005 and 2007.

Brown bears were locally abundant in coastal sedge meadows in early summer and along salmon streams in late summer and autumn. The study area contained low densities of black bears and moose. Caribou are very rare in the study area.

Furbearers occur in low numbers in the study area. Only red foxes and river otters were recorded on wildlife surveys; no wolves, coyotes, or wolverines were seen in the study area during 2004 through 2007. The reported harvests of furbearers are low.

Because most of these mammal species are highly mobile and cover relatively large home ranges, the numbers in the study area vary seasonally and even daily; in addition, the detectability of animals in thick shrub and forest vegetation is low. Therefore, the numbers observed are low estimates of the use of this area by mammals throughout the year.

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41.2.10 Acknowledgments

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TABLES

TABLE 41.2-1
Species and Numbers of Mammals Recorded during Large-mammal Surveys, Cook Inlet Drainages, 2004 through 2007

Survey Type	Year	Date	Brown Bear	Black Bear	Moose	Red Fox
Fixed-wing Surveys[a]	2004	April 12	**0**	0	**0**	0
		May 21	**1**	0	**0**	0
		June 30	**38**	0	**0**	0
		October 20	**0**	0	**0**	0
		November 30	**0**	0	**1**	1
		Total	39	**0**	1	**1**
	2005	April 24-25	**0**	0	**0**	0
		May 3-4	**0**	0	**0**	0
		May 10-11	**0**	0	**0**	0
		May 25-26	**18**	4	**1**	0
		May 31	**54**	0	**0**	0
		June 28-29	**75**	1	**0**	0
		July 21-22	**17**	1	**0**	0
		July 26	**0**	0	**0**	0
		August 11	**9**	0	**0**	0
		August 17	**12**	0	**0**	0
		August 21	**7**	0	**0**	0
		September 8	**8**	0	**0**	0
		September 29	**5**	0	**0**	0
		October 10	**1**	0	**1**	0
		December 13	**0**	0	**9**	0
		Total	206	**6**	11	**0**
	2007	May 21	**6**	0	**0**	0
		June 19-20	**168**	1	**1**	0
		July 16-17	**62**	1	**0**	0
		July 26-27	**40**	0	**0**	0
		August 14-16	**22**	0	**0**	0
		August 29-30	**19**	0	**0**	0
		September 12-13	**5**	0	**0**	0
		October 11-12	**0**	0	**0**	0
		Total	322	**2**	1	**0**
Stream/Den Survey	2004	August 20	**7**	0	**0**	0
Den Survey	2005	August 30	**2**	0	**0**	0

a. Fixed-wing surveys include harbor seal surveys flown by terrestrial mammal survey crew.

TABLE 41.2-2
Species and Numbers of Mammals Recorded Incidentally during Other Wildlife Surveys, Cook Inlet Drainages, 2004 through 2007

Survey Type	Year	Month	Brown Bear	Black Bear	Moose	Red Fox	River Otter
Incidental Observations	2004	May	**9**	0	**0**	2	0
		June	**36**	0	**0**	0	0
		September	**12**	0	**0**	0	0
		October	**2**	0	**0**	0	0
		December	**0**	0	**0**	0	3
		Total	59	**0**	0	**2**	**3**
	2005	May	**22**	0	**1**	3	2
		June	**24**	0	**0**	0	0
		July	**26**	0	**0**	0	0
		August	**29**	2	**0**	0	0
		September	**17**	0	**0**	0	0
		October	**3**	0	**2**	2	0
		Total	121	**2**	3	**5**	**2**
	2006	April	**0**	0	**0**	0	1
		May	**0**	0	**0**	0	1
		October	**1**	0	**0**	0	0
		Total	1	**0**	0	**0**	**2**
	2007	May	**2**	0	**4**	0	0
		August	**24**	1	**0**	0	0
		September	**2**	0	**0**	0	0
		October	**1**	0	**17**	0	0
		Total	29	**1**	21	**0**	**0**

FIGURES

THE pebble PARTNERSHIP

Figure 41.2-1
Aerial-survey Areas for Large Mammals, Cook Inlet Drainages, 2004–2005

Legend

- 2004 Aerial Survey Area
- August 2004 Stream Survey
- 2005 Aerial Survey Area
- Existing Road

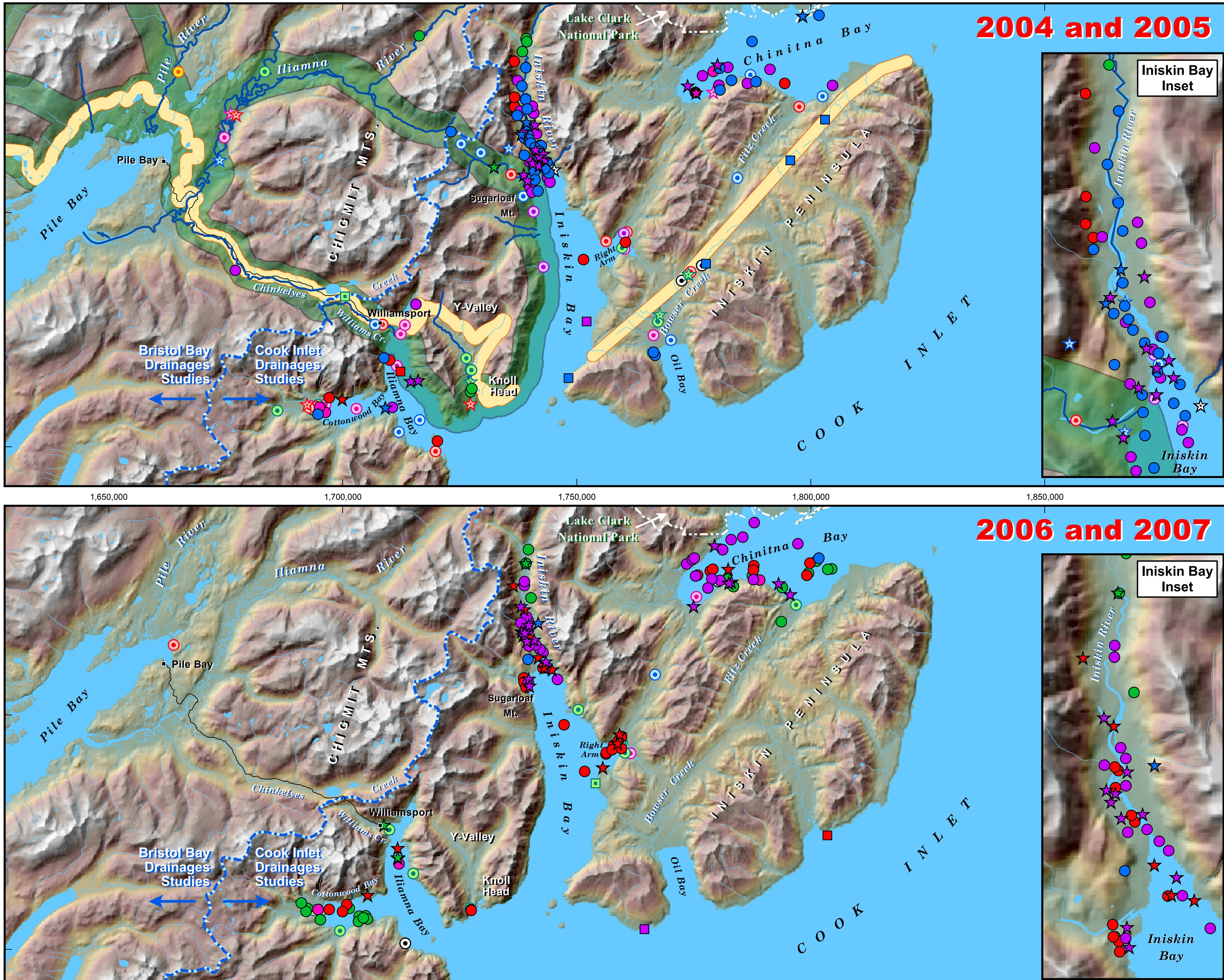
Miles: 0 1 2 3 4 5 6
Kilometers: 0 2 4 6 8 10

N

Scale 1:275,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-2-1_MammalSA_CookInl_PLP_EBD_v02.mxd	Date: March 10, 2011
Version: 2	Author: ABR-AZC



THE pebble PARTNERSHIP

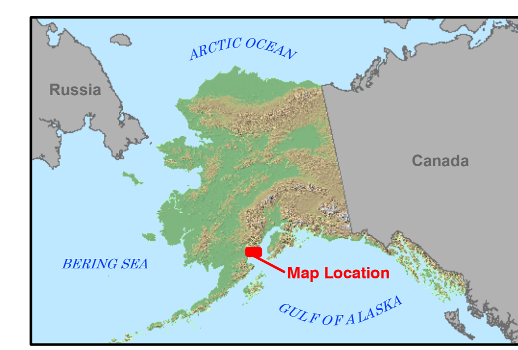
Figure 41.2-2
Bear Observations, Cook Inlet Drainages, 2004–2007

Legend

	Large Mammal Surveys[a]		Other Surveys
	Brown Bear w/ cubs	Brown Bear w/o cubs	Black Bear w/o cubs
April			
May			
June			
July			
August			
September			
October			

[a]Includes sightings made during harbor seal surveys.

- 2004 Survey Area
- August 2004 Stream Survey
- 2005 Survey Area
- Existing Road



Miles: 0 1 2 3 4 5 6 7 8
Kilometers: 0 2 4 6 8 10 12

N

Scale 1:260,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-2-2_BearObs_2004-07_CI_PLP_EBD_v02.mxd	Date: March 24, 2011
Version: 2	Author: ABR-AZC

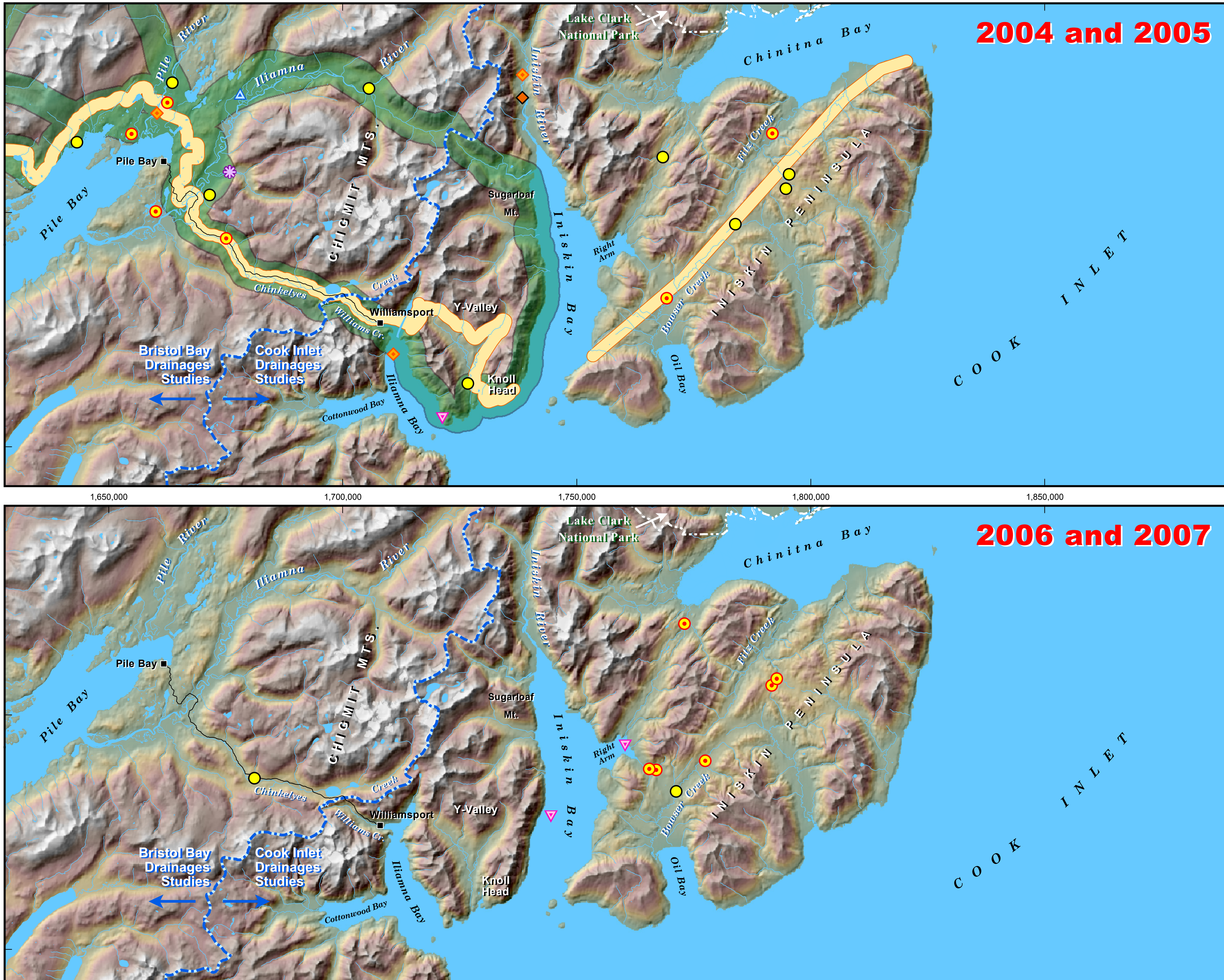


Figure 41.2-3
Observations of Other Mammals, Cook Inlet Drainages, 2004–2007

Legend

	Large Mammal Surveys[a]	Other Surveys
Moose	●	●
Red Fox	◆	◆
River Otter		▽
Wolf		△
Wolverine		✱

[a]Includes sightings made during harbor seal surveys.

2004 Survey Area

2005 Survey Area

Existing Road

Miles: 0 1 2 3 4 5 6 7 8

Kilometers: 0 2 4 6 8 10 12

N

Scale 1:260,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-2-3_OtherMam_2004-07_CI_PLP_EBD_v02.mxd	Date: March 24, 2011
Version: 2	Author: ABR-AZC

41.3 Raptors

41.3.1 Introduction

Researchers conducted surveys in 2004 and 2005 for all large tree- and cliff-nesting birds of prey (raptors) in the Cook Inlet drainages study area. Several raptor species were included in these studies because of their legal or conservation status, traditional use of nesting territories, and potential sensitivity to disturbance. Bald and Golden eagles were included because they are afforded special protection under the Bald and Golden Eagle Protection Act (16 USC, Section 668). The American Peregrine Falcon (*Falco peregrinus anatum)*, whose range probably includes the Lake Clark/Iliamna region (White, 1968), was delisted as an endangered species in 1999 (64 FR 46542). This subspecies was included in the Pebble Project studies with other cliff-nesting raptors (including Golden Eagle, the coastal subspecies of Peregrine Falcon [*F. p. pealei*], Gyrfalcon, and Rough-legged Hawk) because of continued agency interest in their populations and because some of these raptors are sensitive to disturbance, particularly near their nests during the breeding season (USFWS, 2002; Audubon, 2002). The Northern Goshawk is a tree-nesting raptor, and the coastal race in southeast Alaska is listed by the State of Alaska as a Species of Special Concern (ADFG, 1998). Identifying goshawk nest sites is regularly a component of baseline surveys throughout interior and coastal Alaska. Other tree-nesting species (including Bald Eagle, Osprey, and Great Horned Owl) were also identified during surveys. Finally, the study includes records of Common Raven nests because of their close association with raptors (i.e., ravens build many nests subsequently used by raptors) and humans (e.g., attraction to camps).

41.3.2 Study Objectives

The goal of raptor surveys in the Cook Inlet drainages study area in 2004 and 2005 was to determine the distribution, abundance, and nesting status of raptors in the region.. Researchers recorded all raptor species and raptor nests observed in the field, and placed special emphasis on locating individuals or nests of protected or sensitive species, such as Bald and Golden eagles, Peregrine Falcons, and the Northern Goshawk. Researchers did not make concerted efforts to determine the nesting status or abundance (or to locate nests) of small raptors, including Merlins and small woodland owls (e.g., Boreal Owl); extensive ground surveys would be required to census for these species. Raptor surveys in the study area in 2004 and 2005 had the following objectives:

- Locate, identify, and map primary cliff- and tree-nesting raptor nest sites.
- Delineate important cliff-nesting raptor habitats.
- Compile a comprehensive list of raptor species nesting in and using the area.

An additional study objective was added in 2005: determine the rates of nesting success and productivity of nesting raptors.

41.3.3 Study Area

The study area for raptors in the Cook Inlet drainages included all suitable cliff habitats and woodland tracts that could provide nesting platforms for large cliff- and tree-nesting raptors (Figure 41.3-1). This study area lies entirely in the Alaska Range ecological zone (Gallant et al., 1995). The area has generally steep topography with rocky and brush-covered slopes. Much of the area is above tree line and is barren of vegetation. Upper slopes and wind-blown areas are dominated by low to high scrub communities, while white spruce forests are extensive on the Iniskin Peninsula. At the southwestern extent of the study area (e.g., Cottonwood Bay), landscapes begin to transition more into the Alaskan Peninsula Mountains ecological zone where spruce forests are greatly reduced and shrub communities are more dominant (Gallant et al., 1995).

Suitable habitats for cliff-nesting raptors in the study area range from low rocky cliffs along the coastline (less than 15 meters of vertical relief) to an extensive band of large cliffs and rock outcroppings (greater than 100 meters) between Iliamna Bay and Iniskin Bay and along Mt. Pomeroy and the Tilted Mountains on the Iniskin Peninsula. Although suitable cliff habitats appear abundant, many cliffs probably are above some altitudinal limits for nesting raptors at this latitude because of persistent deep snow cover during the spring arrival and nest-initiation period. Suitable habitats for tree-nesting raptors are extensive and include poplar trees on many of the drainages in the area and large white spruce trees common along the coast from Iniskin Bay to Chinitna Bay and inland on the Iniskin Peninsula.

41.3.4 Previous Studies

Specific information on the nest sites of raptors in the study area does not exist. General information on the relative abundance and distribution of some species, however, was summarized from a search of literature and unpublished agency reports for the greater Lake Clark/Iliamna region. Primary accounts from this region include biological reconnaissance at the turn of the century (Osgood, 1901, 1904), natural resource inventories on national interest lands (Cahalane, 1959; Evans and Cuccarese, 1977; Racine and Young, 1978), and coastal surveys related to Outer Continental Shelf Environmental Assessment Program (Arneson, 1978).

41.3.5 Scope of Work

The research and field work for this study were conducted during the summers of 2004 and 2005. Robert J. Ritchie and John E. Shook, of ABR, Inc., Fairbanks, Alaska, conducted the study according to the approach described in Chapter 9 of the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and the *Draft Environmental Baseline Studies, 2005 Study Plan* (NDM, 2005). Minor modifications in study protocols are described in the methods section. Specific project activities were as described below:

- Compile a list of possible raptors and synthesize literature to help determine their probable breeding status in the region (2004-2005).
- Conduct aerial surveys to locate cliff- and tree-nesting raptors within the study area (2004-2005).
- Identify habitats for nesting raptors in the study area (2004-2005).
- Revisit known nest sites during the nestling period to assess nesting success and productivity (2005).

41.3.6 Methods

41.3.6.1 Occupancy Surveys

Field personnel conducted two aerial surveys by helicopter in the study area to identify potential habitats and to locate and document the status (occupancy) of raptor nests in 2004 and 2005 (Table 41.3-1). The first survey each year was conducted before deciduous-tree leaf-out and was timed to identify the nests of tree-nesting species, particularly Northern Goshawk, but also Bald Eagle and other woodland species. (In 2005, surveys specifically for Northern Goshawks were not flown, and surveys for other tree-nesting raptors were flown later in the season.)

The second survey each year was timed and conducted to coincide with peak occupancy by cliff-nesting raptors, particularly Golden Eagle, Gyrfalcon, Peregrine Falcon, and Rough-legged Hawk. Common Raven nests also were recorded on both surveys. In 2004, some efforts were made to increase the coverage of suitable Bald Eagle habitats during this second survey, since pre-leaf-out surveys had been conducted during Bald Eagle arrival and less conspicuous inactive nests (e.g., nests in spruce trees) may have been missed.

The helicopter followed a slow (60 to 90 kilometers per hour), low-level (less than 50 meters above ground level) flight pattern during both aerial surveys. Two observers were seated on the same side of the aircraft. During the pre-leaf-out survey, researchers scrutinized all suitable forest stands (i.e. large timber) for raptor nests and signs of occupancy (e.g., perched birds or birds showing territorial behaviors [aggressive flight]). Standard operating procedures for woodland species included searching suitable forest stands in riparian areas, on hillsides, and along coastlines and lakeshores (including island shorelines).

During cliff-nesting surveys (some cliff areas were searched during the pre-leaf-out survey), observers searched all cliffs, rock outcrops, and soil bluffs for raptor nests and signs of occupancy (e.g., white-wash, adults). Standard operating procedures for helicopter searches of cliff habitats included using an angled approach toward the prospective cliff or bank area from at least 0.8 kilometers away from the site and slowly approaching potential nesting areas. This technique was employed to reduce the chance of startling incubating birds (Fyfe and Olendorff, 1976). Multiple passes of some cliff habitats were necessary.

When a nest or suggestions of nesting (e.g., an aggressive pair) occurred, observers recorded the location on a U.S. Geological Service (USGS) map and with an onboard or hand-held global positioning position (GPS). The following additional data were recorded on field data forms:

- Species (if determined, otherwise “unidentified”).
- Number of adults and their behavior (particularly if defensive and suggesting occupancy).
- Nest status (inactive or unoccupied, active or occupied, and undetermined).
- Tree species or substrate type (cliff, bluff top).
- Habitat type (riparian, lacustrine, montane, coastal).
- Nest condition and approximate location on substrate.
- Height and exposure (for cliff nests).

All nest locations later were entered into a geographic information system (GIS) database (using *ArcGIS 9* software). To reduce additional disturbance of incubating birds at active nests, GPS locations were often taken at distances greater than 50 meters; therefore, map locations may not be exact.

A nest was determined to be *occupied* if an adult was observed to be incubating, or if eggs and/or young were observed, or if a pair of adults was closely associated with a nest (either exhibiting defensive behaviors near the nest or perched in or adjacent to the nest). A nest was determined to be *unoccupied* (inactive) if a nest was found, but no adults or signs of nesting activity were obvious (Steenhof, 1987). Occasionally, adult birds were observed near suitable habitat, but no nests were obvious. If exhaustive searching of that terrain did not identify a nest platform and the pair did not show defensive behaviors, these observations were not recorded as nest sites. These locations can be retrieved from the data set. Many of these areas, where only adult pairs were observed in 2004, were revisited in 2005 to better establish nesting status.

41.3.6.2 Productivity Surveys

In 2005, a second set of aerial surveys was conducted during the nestling period to determine the success and productivity of nests found during the first surveys in the study area (Table 41.3-1). One survey, conducted in late June/early July, primarily served to determine the success of early-nesting species (e.g., Gyrfalcon, Golden Eagle). A second survey was conducted in mid-July for later nesting species (e.g., Rough-legged Hawks) or species with a long nestling period (e.g., Bald Eagle) in the study area. A third survey was conducted in early August to more clearly determine nesting success and productivity at some late-hatching sites (e.g., Bald Eagle) where brooding adults did not allow a good view of the nest contents in early July.

A nest was considered *successful* if at least one live nestling at about 80 percent of the average age of first flight (preferably more than three weeks old for medium-sized raptors and more than five weeks for large raptors) was observed during productivity surveys (Steenhof, 1987). Productivity was calculated as number of young per occupied nest or total number of pairs, and number of young per successful nest or successful pair.

41.3.7 Results and Discussion

At least 18 species of raptors (11 diurnal raptors and seven owl species) probably occur in the greater Iliamna Lake/Lake Clark Region, including the study area (Appendix 41.3A). (This list was developed from the literature and unpublished reports, our aerial surveys, and incidental observations from other wildlife surveys [e.g., land bird and waterbird studies].) Aerial surveys recorded five raptor species and Common Ravens in the study area (Table 41.3-2). Of these, Bald and Golden eagles, Peregrine Falcon, and Common Raven were confirmed as nesting in the area (Table 41.3-3), but behaviors, suitable habitats, and general breeding range of the two other raptors observed (Rough-legged Hawk, Merlin) suggested the probability of nesting for these species as well. Nesting success and productivity data could be determined for three raptor species and Common Ravens (Table 41.3-4). Additional species, such as woodland raptors (e.g., Northern Goshawks, Great Horned Owls), also may nest in this area (NPS 2000), but were not found during the Pebble Project surveys.

41.3.7.1 Nest Distribution, Abundance, and Occupancy

Researchers identified a total of 23 raptor nests in the study area during the 2004-2005 study; 13 raptor nests were found in the study area during 2004 (Figure 41.3-2, Table 41.3-3) and 20 were found in 2005 (Figure 41.3-3, Table 41.3-3). As indicated by the respective annual totals, some nests found in 2004 were also used in 2005, but the greater number of nests found in 2005 was because a larger area was searched in that year (Figure 41.3-1). (One Golden Eagle nest found in 2004 was not revisited in 2005 because proposed development scenarios had shifted farther south and this site was outside the extent of the 2005 study area). Readers should note that some nests located in the Bristol Bay drainages study area to the west [Section 16.9] may appear on figures in this section on the Cook Inlet drainages study area.)

Golden Eagle

Researchers identified four Golden Eagle nests in the study area (Figures 41.3-2 and 41.3-3). One additional nest also may have been built by this species, but nest conditions (e.g., remnants) prevented a more specific identification. All of the Golden Eagle nests and the unknown species nest were on large cliff faces west of Iniskin Bay. In addition, Golden Eagles were recorded perched or flying in the Tilted Hills (Iniskin Peninsula), but no nests were found. A pair also was observed soaring on the east side of Iliamna Bay, but no nest was found in that area.

Golden Eagles nest throughout Alaska, including southwestern maritime Alaska and the eastern Aleutian Islands (Bailey, 1975; Berns, 1979; Kochert et al., 2002), but are better known for their use of alpine and tundra regions in interior and northern Alaska. Racine and Young (1978) reported that Golden Eagles were fairly common in Lake Clark National Park and likely breed there. Golden Eagles were found regularly breeding in mountains north of Iliamna Lake (this study, Sections 16.3 and 16.9). They are probably less common along the Alaska Peninsula and were absent from species accounts for Katmai National Monument (Cahalane, 1959) and the Alaska Peninsula (Osgood, 1904).

Bald Eagle

The Bald Eagle was the most abundant and widely distributed raptor nesting in the study area, with a total of eight nests found in 2004 (Figure 41.3-2) and an additional eight nests found in 2005 in the region (Figure 41.3-3). At least one nest found in 2004 probably collapsed during the 2004/2005 winter and could not be located during the 2005 surveys. Bald Eagles are common breeding birds in the Cook Inlet/Alaska Peninsula regions (Gabrielson and Lincoln, 1959) and occasional winter visitors along the coastline in this region (Arneson, 1978). Hehnke and White (1978) recorded one occupied nest per 18 miles of shoreline along the Alaska Peninsula (n = 38 nests).

During this study, most nests (87 percent) were located in spruce or cottonwood trees in view of marine habitats; the remaining two Bald Eagle nests were located on the ground on top of, or on the face of, a coastal bluff. Bald Eagles regularly nest on the ground, on the top of cliffs, and on steep slopes in coastal southwestern and southcentral Alaska where trees are not available (Troyer and Hensel, 1965; Hehnke and White, 1978; Gill et al., 1981).

Occupancy of Bald Eagle nests was 63 percent in 2004 and 73 percent in 2005 (Table 41.3-3). Comparative occupancy information is not available for many Alaska populations because the early surveys required to determine occupancy are often not undertaken. However, rates described during this study fit within a range of occupancy rates for Bald Eagles recorded on the Kodiak National Wildlife Refuge (60 percent; Zwiefelhofer, 1997), the coastline of Lake Clark National Park in 1994 and 1996 (38 percent in 1994 and 47 percent in 1996; Bennett, 1996), in unoiled areas of Prince William Sound (58 percent; White et al., 1995), and for seven continental North America populations (mean = 71 percent, range 53.7 to 91.0 percent; Stalmaster, 1987).

Peregrine Falcon

A Peregrine Falcon pair occupied a cliff at the mouth of Cottonwood Bay in 2004 and 2005 (Figure 41.3-2). The cliff was fairly typical of habitats used by peregrines in coastal Alaska: good ledges, sheer faces, and relatively inaccessible to predators. This Peregrine Falcon nest was the only one found in the study area. In addition, single Peregrine Falcons were observed near a suitable cliff in Chinitna Bay (Sea Otter Point) during aerial surveys and along the eastern shoreline at the mouth of Iniskin Bay (base of Mt. Pomeroy) during boat surveys for coastal waterbirds (Rose, pers. comm., 2004).

Peale's Peregrine Falcons (*Falco peregrinus pealei*) are relatively common breeding raptors along the Alaska Peninsula (Cade, 1960; Evans and Cucarese, 1977). They nest on vertical cliffs usually facing the ocean and often are associated with seabird colonies (Beebe, 1960). Nests in trees have been recorded in the southern portion of their range in Southeast Alaska and Canada (Campbell et al., 1977; Van Horn et al., 1982). This same subspecies is also likely to occupy the study area (White, 1968). This coastal subspecies of the Peregrine Falcon is larger, generally darker, and less migratory than the other two races of peregrines (*F. p. anatum* and *F. p. tundrius*) that breed in Alaska (White et al., 2002). Close inspection of photographs of adults and recently fledged young birds occupying the Cottonwood Bay site in 2005 were not conclusive as to subspecies, however.

Other Raptors and Common Ravens

Researchers recorded two other diurnal raptor species during aerial surveys in the area. Pairs of Merlins were recorded near the coast in the Y Valley and on a brush-covered slope on the east side of Iniskin Bay. Both pairs responded to the aircraft as if they might be defending occupied territories (i.e., ground nests). Merlins often use corvid nests such as those built by Black-billed Magpies, but can use other substrates such as cliff stick nests and nests on the ground under roots or at the base of small alders (Sodhi et al., 1993). Merlins were commonly recorded on the aerial surveys during this study in the deposit area and between the deposit area and the coast (see Sections 16.3 and 16.9, respectively).

Rough-legged Hawks were observed perched and flying along ridges on Mt. Pomeroy, but no nests were found. This pan-boreal species is typically associated with tundra areas during the breeding season, and coastal cliffs are often used by breeding pairs (Bechard and Swem, 2002). Rough-legged Hawks nest on the Alaskan Peninsula and associated islands (Osgood, 1904; Cahalane, 1959; Gill et al., 1981), as well as on the Aleutian Islands (Murie, 1959; Bechard and Swem, 2002).

A pair of Common Ravens was recorded on one cliff along Chinitna Bay. Common Ravens are regular nesting species in coastal Alaska using trees and cliffs for their nesting substrates (Boarman and Heinrich, 1999). The locations of raven nests are important because Ravens often associate with humans and identifying nests before development may be useful in assessing increases in their population. They also "improve" habitats for some cliff-nesting species that do not build their own nests (e.g. Gyrfalcon, Peregrine Falcon; Cade, 1960)

Researchers did not record Northern Goshawks or their nests in the study area, but some woodland habitats appeared to be suitable (e.g., open mixed forests) for this species. Range maps for this species include the Iliamna Lake area as the southwestern extent of their range in Alaska (Squires and Reynolds, 1997), and Northern Goshawks are probably uncommon breeders in the region, possibly visiting the area as migrants as well. Observations of a few goshawks at Katmai National Monument in late August and September 1954 were described in the context of migration (Cahalane, 1959).

41.3.7.2 Nesting Success and Productivity

Researchers located nine successful nests representing three raptor species in the study area in 2005 (Table 41.3-4). Accurate counts of young were made at all of these nests. The single Common Raven nest was not successful.

Golden Eagle

Researchers determined that two Golden Eagle nests were occupied in 2005. Both nests were successful and produced a total of three young (Table 41.3-4, Figure 41.3-3). Therefore, productivity was 1.5 young per both successful nest and occupied nest in 2005. In other studies, the mean number of young per successful nest ranged from 1.1 to 1.5 in northern Alaska (Ritchie and Curatolo, 1982; Young et al., 1995).

Bald Eagle

Eleven occupied Bald Eagle nests (Figure 41.3-3) were revisited in July and August 2005 to determine nesting success and productivity. Fifty-five percent of occupied nests were successful (Table 41.3-4). Nesting success (percent of occupied nests that produced at least one young) was 62 percent for nests on the Alaska Peninsula in 1970 (n = 38; Hehnke and White, 1978) and ranged from 65 to 88 percent for Katmai National Monument in the 1970s (e.g., n = 20; Troyer, 1979). Nesting success was lower (53 percent) for Bald Eagles nesting along the Lake Clark National Park/Cook Inlet Coastline (Bennett, 1996). Nesting success was determined to be 54 percent for 518 occupied nests in Kodiak National Wildlife Refuge in 1997 (Zwiefelhofer, 1997).

Six successful nests in the study area produced a total of 11 young or 1.8 young per successful nest (1.0 young per occupied nest), which generally was similar to other Bald Eagle populations in coastal Alaska. For example, productivity rates of 1.6 young per successful nest and 1.0 young per occupied nest were calculated for Bald Eagles nesting on the southern Alaska Peninsula in 1970 (Hehnke and White, 1978). Productivity was higher in the Katmai National Monument; young per successful nest ranged from 1.7 to 2.3 between 1974 and 1979 (e.g., Troyer, 1979). Extensive surveys of the Kodiak National Wildlife Refuge (Zwiefelhofer, 1997) reported productivity rates of 1.5 young per successful nest and 0.8 young per occupied nest (n = 280 successful nests). The average productivity for a number of Bald Eagle populations in North America in 1970 through 1982 was 1.6 per successful nest and 0.9 per occupied nest (Stalmaster, 1987).

Peregrine Falcon

The Peregrine Falcon pair near Cottonwood Bay was successful, and three young were counted during aerial surveys in July, resulting in a productivity rate of 3.0 young per successful and per occupied nest

(Table 41.3-4, Figure 41.3-3). This productivity rate is at the high end of rates available for other coastal areas of Alaska and Canada. Productivity rates for Peale's Peregrine Falcon were 2.7 young per successful nest in southeast Alaska in 1992 (Schempf, 1992) and ranged from 2.1 to 3.2 young per successful nest on the Queen Charlotte Islands, British Columbia, in 1952 through 1980 (Munro and van Drimmelen, 1988).

41.3.7.3 Habitat Suitability for Breeding Raptors

Woodland Habitats

The best woodland habitats suitable for tree-nesting raptors (including large cottonwoods) occur in the lower to middle reaches of major drainages entering the bays and marine areas in the study area, including the drainage at the head of Cottonwood Bay, Y Valley, Fitz Creek, Bowser Creek, and Brown Creek. In addition, scattered cottonwood and spruce trees are found along the shoreline from Cottonwood Bay to outer Iniskin Bay and are more abundant from the east side of Iniskin Bay to the south shoreline of Chinitna Bay. Finally, across the central region of the Iniskin Peninsula there are large homogenous stands of spruce and riparian stands of cottonwood, which offer potential substrates for hole-nesting and platform-nesting raptors.

Cliff Habitats

Suitable habitats for cliff-nesting raptors occur along the entire coast in the study area from Cottonwood Bay to Oil Bay and again in Chinitna Bay near Sea Otter Point. Suitable cliffs generally are arranged in two tiers:

1. Fronting the ocean (less than 15 to 100 meters in height), but primarily at the outer extent of each bay (i.e., headlands).
2. A higher (often more than 100 meters), nearly continuous band of large cliff faces which often extend inland (Y Valley) between Iliamna Bay and Iniskin Bay and along Mt. Pomeroy and the Tilted Mountains on the Iniskin Peninsula as far north as Chinitna Bay.

Although suitable cliffs appear to be abundant, few signs of raptor nests or regular use (e.g., protected, white-washed, covered perches) were recorded, suggesting that something other than the availability of apparently stable, inaccessible cliff structures may affect the distribution and abundance of cliff-nesting raptors in the study area. For instance, many inland cliff faces are probably above altitudinal limits for nesting raptors at this latitude because of persistent, deep snow cover during the time when the species arrive in spring and begin nest initiation. Other density-dependent factors such as food supply and intra- and interspecific territorial behaviors also might affect the use of these habitats.

41.3.7.4 Survey Efficacy

Suitable cliff and woodland areas were thoroughly searched in both years in the study area. In particular, the inventory of cliff-nesting sites for Golden Eagle, Gyrfalcon, Peregrine Falcon, and Rough-legged Hawk was complete, especially for discrete cliff faces and prominent coastal bluffs in the study area. Areas used traditionally by these species were obvious in the latter habitats. More problematic, however, was the researchers' ability to thoroughly investigate every cliff face on extensive mountainous regions (e.g., Tilted Hills) where ledges and remnants of stick nests might be less conspicuous.

Researchers were most effective at locating nests of tree-nesting species during surveys of woodlands along shorelines of lakes, rivers, and the coasts, where the primary tree-nesting species of interest in this study usually select nest sites. Exceptions might include woodland raptors such as the Northern Goshawk or Great Horned Owl, which often locate their nests in more dense and complex woodlands. In 2004, surveys were conducted before all species of tree-nesting species had occupied nest sites (late April), to increase the chance of recording early nesters, particularly Northern Goshawks. This early survey probably resulted in underestimated occupancy of nests by other tree-nesting species, such as the Bald Eagle and Osprey. This possible cause for underestimation of nest occupancy for other species, however, was "corrected" in 2005, when spring surveys were conducted at a later date (mid-May). Furthermore, because of the heavy cover of spruce forest on the Iniskin Peninsula, stick nests in this forest type may have been overlooked for some species. In particular, nests of the Northern Goshawk—which typically are located in deciduous trees, but have been located in coniferous trees in other parts of their coastal range (ADFG, 1996)—may have been overlooked. More intensive survey techniques, including broadcast calls, might be required to identify their nests in this type of habitat.

Given these caveats, researchers did not record any Northern Goshawks during any of the surveys in the study area, which is at the southern extent of the goshawk breeding range in southwestern Alaska (Squires and Reynolds, 1997); this suggests that this habitat may not be regularly occupied by breeding goshawks. Similarly, nests of other woodland raptors (e.g., Great Horned Owls) were not found during the surveys, although their absence may be an artifact of the survey technique (i.e., nests are not easily discernible in dense conifer forests). Unfortunately, little information on the density of these species in the region is available to improve this assessment.

41.3.8 Summary

Researchers conducted aerial surveys to gather information on the abundance, distribution, and breeding status of large cliff- and tree-nesting raptors in the study area in 2004 and 2005. Surveys included several raptor species because of their legal or conservation status, sensitivity to disturbance, and traditional use of nesting territories. Large raptors, such as Bald and Golden eagles, Peregrine Falcons, Gyrfalcons, Ospreys, and Northern Goshawks, were the primary focus of the surveys.

Surveyors successfully mapped the general nest distribution, relative abundance, and breeding status of large raptors in the study area. Twenty-three nests representing three species of raptors and Common Ravens were found in the study area. Bald Eagles were the most abundant nesting species (70 percent of total nests), followed by Golden Eagles (17 percent). Peregrine Falcons also were recorded nesting in both years at one coastal-cliff location.

Most Bald Eagle nests were located in the fringe of trees bordering the coastline or along the lower reaches of rivers entering the region's bays. Although no Northern Goshawk nests were found, habitat for the species is available, although limited to sheltered stands of trees along drainages in the study area or in the extensive conifer forests on the Iniskin Peninsula. Furthermore, this area may be the southern extent of the Alaskan ranges for many woodland-nesting raptor species.

Habitat for cliff-nesting species, on the other hand, is abundant along the coast at low elevations fronting the ocean from Cottonwood Bay to Chinitna Bay and at higher elevations in the same coastal area, as well as inland in Y Valley and along Mt. Pomeroy, the Tilted Hills, and other areas on the Iniskin Peninsula.

Use of these habitats, however, seems spotty and might be constrained by other factors (e.g., weather, food supply, density).

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TABLES

TABLE 41.3-1
Dates of Aerial Surveys for Raptors in the Cook Inlet Drainages Study Area, 2004 and 2005

Survey Type	Species of Interest	2004	2005
Occupancy Survey	Tree-nesting species	April 22	May 6-7
Occupancy Survey	Cliff-nesting species	May 24-26	May 26
Productivity Survey	Early nesting species	—	June 30
Productivity Surveys	Later nesting species	—	July 17-18, August 15-16

TABLE 41.3-2
Status of Raptor Species Observed during Aerial Surveys in the Cook Inlet Drainages Study Area, 2004 and 2005

Common Name	Scientific Name	Status	References
Rough-legged Hawk	Buteo lagopus	Probably breeding	This study
Golden Eagle	Aquila chrysaetos	Breeding	This study
Bald Eagle	Haliaeetus leucocephalus	Breeding	This study
Peregrine Falcon	Falco peregrinus	Breeding	This study
Merlin	Falco columbarius	Probably breeding	This study
Common Raven	Corvus corax	Breeding	This study

TABLE 41.3-3
Numbers and Status of Raptor Nests in the Cook Inlet Drainages Study Area, 2004 and 2005

	2004			2005		
Species	**Unoccupied**	**Occupied (%)**	**Total**	**Unoccupied**	**Occupied (%)**	**Total**
Golden Eagle	2	1 (33)	3	1	2 (67)	3
Bald Eagle	3	5 (63)	8	4	11 (73)	15
Peregrine Falcon	0	1 (100)	1	0	1 (100)	1
Common Raven	0	0	0	0	1 (100)	1
Unidentified raptor [a]	1	0	1	0	0	0
Total nests	6	7	13	5	15	20

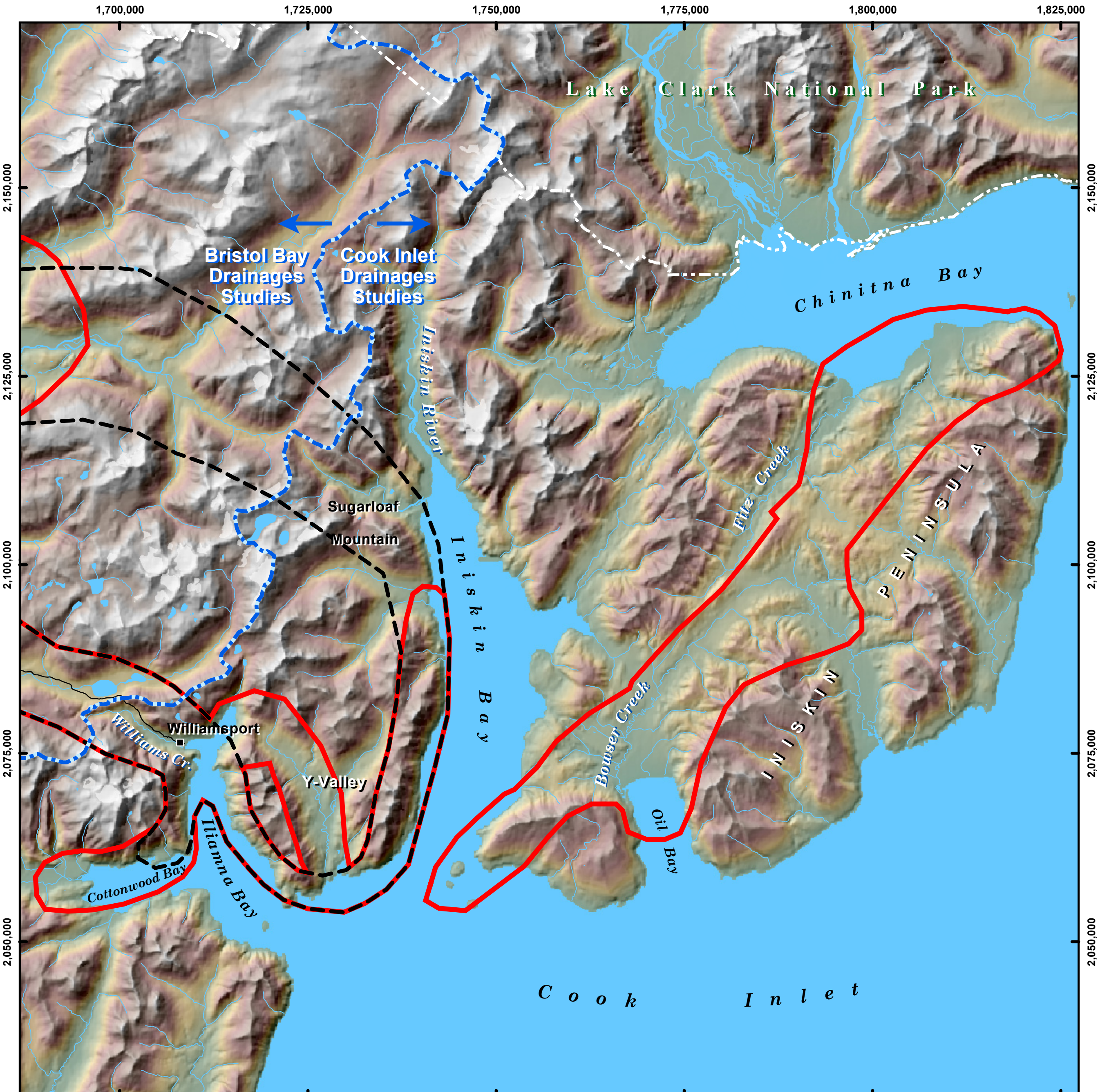
Notes:

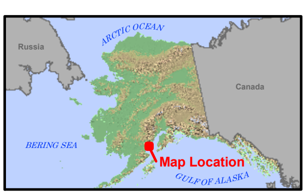
a. Unidentified raptor include remnant stick nests on cliffs and some smaller stick nests in trees used by woodland species such as Northern Goshawks and Great Horned Owls.

TABLE 41.3-4
Nesting Success and Productivity of Raptor Nests in the Cook Inlet Drainages Study Area, 2005

Species	**No. Occupied Nests**	**No. Successful Nests**	**% Successful Nests**	**No. Young**	**Young/ Occupied Nest**	**Young/ Success. Nest**
Golden Eagle	2	2	100	3	1.5	1.5
Bald Eagle	11	6	55	11	1.0	1.8
Peregrine Falcon	1	1	100	3	3.0	3.0
Common Raven	1	0	0	0	—	—

FIGURES





Miles: 0 1 2 3 4 5

Kilometers: 0 2 4 6 8

Scale1:250,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

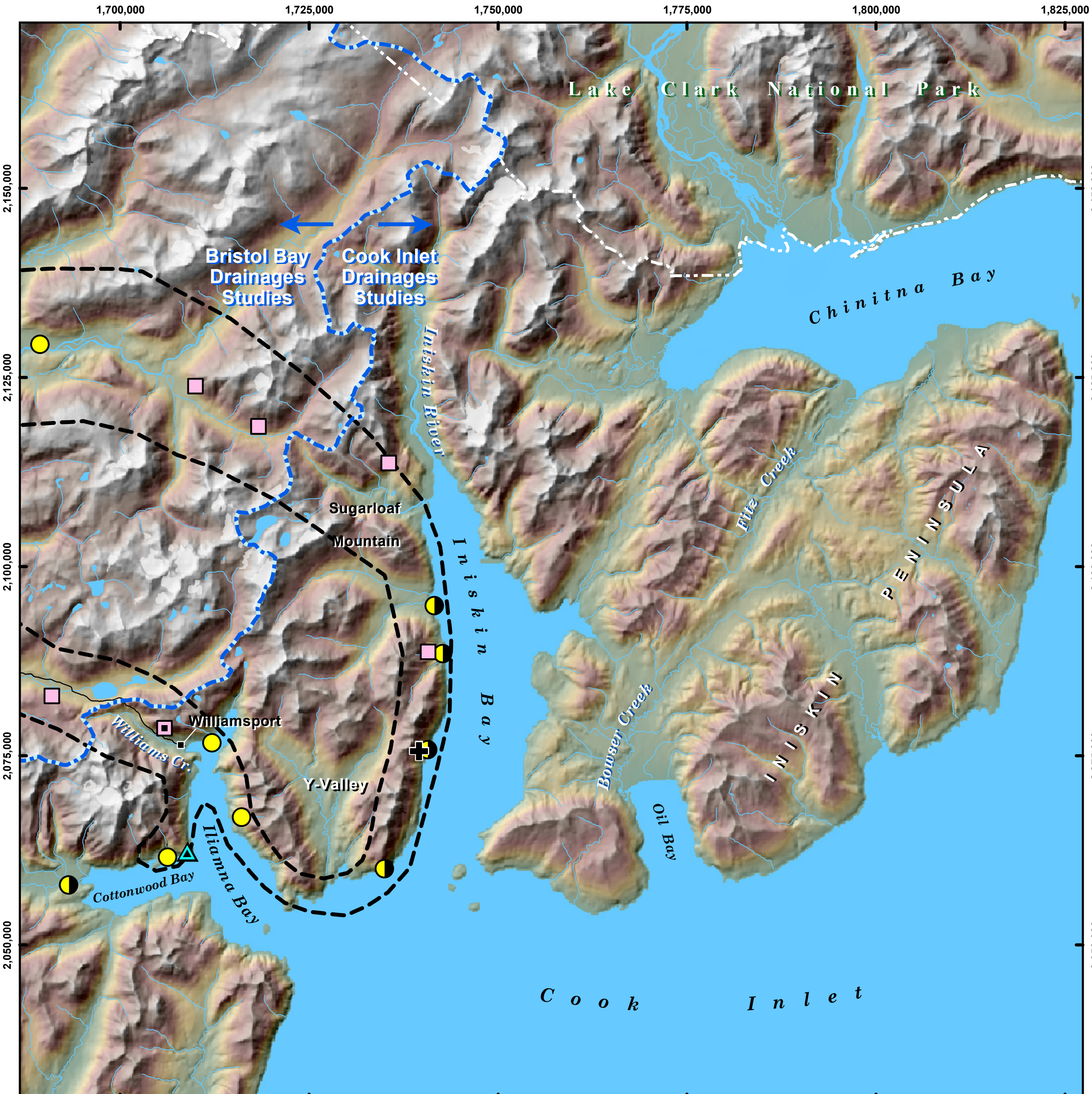
Legend

- 2004 Survey Area
- 2005 Survey Area
- Existing Road

THE pebble PARTNERSHIP

Figure 41.3-1
Survey Areas for Raptors, Cook Inlet Drainages, 2004 and 2005

File: 41-3-1_Raptor_SA_CookIn_PLP_EBD_v01.mxd	Date: July 5, 2010
Version: 1	Author: ABR-AZC



Miles 0 1 2 3 4 5

Kilometers 0 2 4 6 8

Scale1:250,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Legend

	Inactive	Occupied
Golden Eagle	■	■
Bald Eagle	●	◐
Peregrine Falcon		▲
Unidentified Raptor	✚	

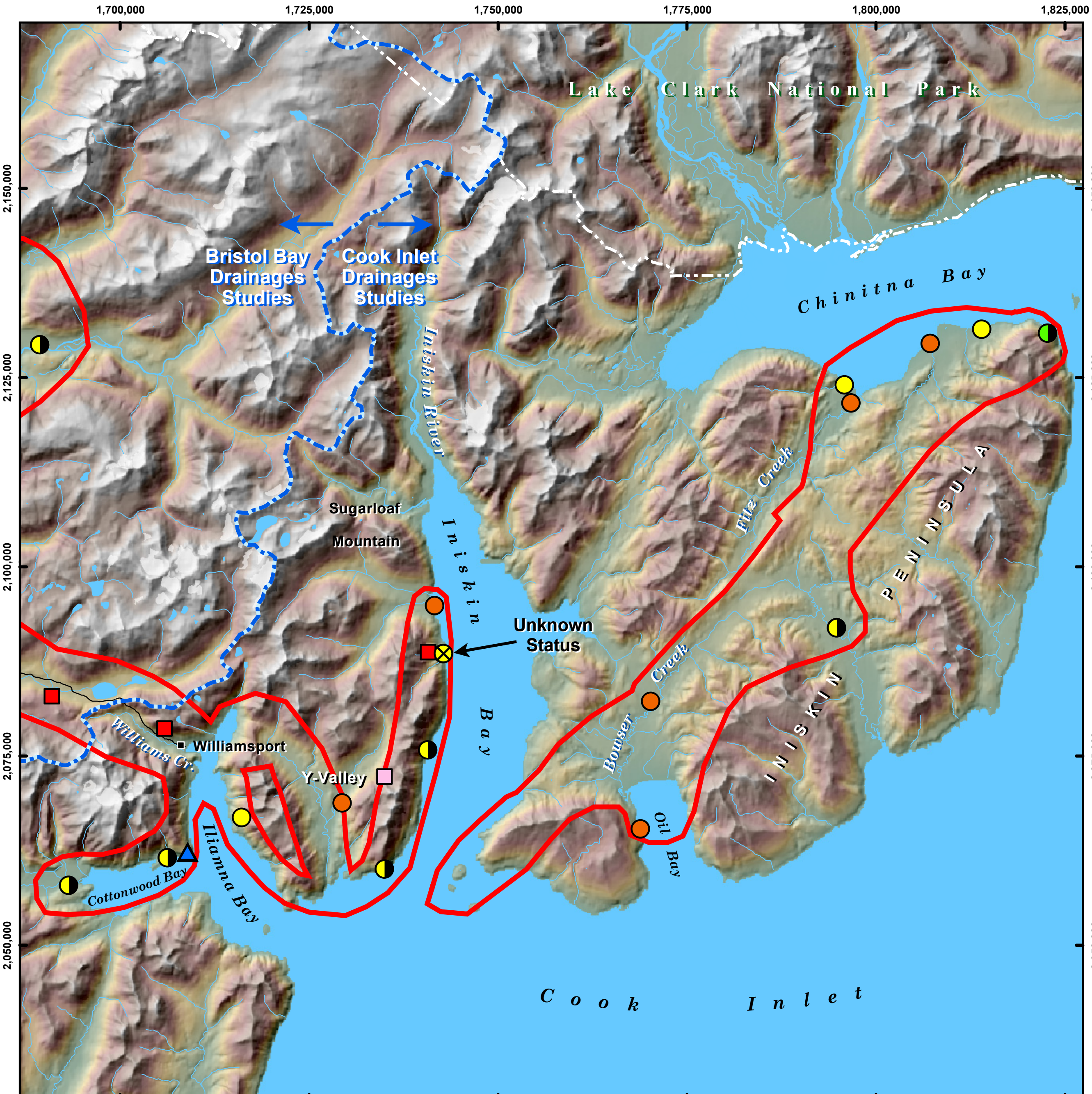
2004 Survey Area

Existing Road

THE pebble PARTNERSHIP

Figure 41.3-2
Raptor Nest Distribution and Status, Cook Inlet Drainages, 2004

File: 41-3-2_RaptDist04_CookIn_PLP_EBD_v01.mxd	Date: July 5, 2010
Version: 1	Author: ABR-AZC



Miles: 0 1 2 3 4 5

Kilometers: 0 2 4 6 8

Scale1:250,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

Legend

	Inactive	Occupied	Successful
Golden Eagle	■ (pink square)		■ (red square)
Bald Eagle	● (yellow circle)	◐ (half yellow/black circle)	● (orange circle)
Peregrine Falcon			▲ (blue triangle)
Common Raven		◐ (half green/black circle)	

2005 Survey Area

Existing Road

THE pebble PARTNERSHIP

Figure 41.3-3
Raptor Nest Distribution and Status,
Cook Inlet Drainages, 2005

File: 41-3-3_RaptDist05_CookIn_PLP_EBD_v01.mxd	Date: July 5, 2010
Version: 1	Author: ABR-AZC

APPENDICES

APPENDIX 41.3A

Seasonal Occurrence and Relative Abundance of Raptors in the Lake Clark/Iliamna Region

Seasonal Occurrence and Relative Abundance of Raptors in the Lake Clark/Iliamna Region with Notes on Probable Status in the Cook Inlet Drainages Study Area

		RELATIVE ABUNDANCE[a]				
		Lake Clark[b]				Cook Inlet Drainages[c]
Common Name	**Scientific Name**	**Spring**	**Summer**	**Fall**	**Winter**	**Probable Status**
DIURNAL RAPTORS:						
Osprey	*Pandion haliaetus*	R	R, B	R		U Migrant
Bald Eagle	*Haliateetus leucocephalus*	C	C, B	C	R	C Breeding, U Winter
Northern Harrier	*Circus cyaneus*	C	U, B	C		U Breeding
Sharp-shinned Hawk	*Accipiter striatus*	U	U, B	U	R	U Breeding
Northern Goshawk	*Accipiter gentilis*	U	U, B	U	U	U Breeding
Red-tailed Hawk	*Buteo jamaicensis*	U	U, B	U		U Breeding
Rough-legged Hawk	*Buteo lagopus*	U		R		U Breeding
Golden Eagle	*Aquila chrysaetos*	U	U, B	U		U Breeding
Merlin	*Falco columbarius*	U	U, B	U	CA	U Breeding
Peregrine Falcon	*Falco peregrinus*	R	R, B	R	CA	U Breeding
Gyrfalcon	*Falco rusticolus*	R	R, B	R	CA	R Breeding
OWLS:						
Great Horned Owl	*Bubo virginianus*	U	U, B	U	U	U Breeding
Snowy Owl	*Bubo scandiacus*			R	R	AC Migrant?
Northern Hawk Owl	*Surnia ulula*	R	R, B	R	R	R Breeding
Great Gray Owl	*Strix nebulosa*	R	R	R	R	R Breeding
Short-eared Owl	*Asio flammeus*	U	U, B	R	AC	U Breeding
Boreal Owl	*Aegolius funereus*	U	U, B	U	U	U Breeding
Northern Saw-whet Owl	*Aegolius acadicus*	U	U	U	U	Uncommon

Notes:

a. Relative abundance and breeding codes:
A=abundant, C=common, U=uncommon, R=rare, CA=casual, AC=accidental, and B= known nest records.

b. Main Source: National Park Service Lake Clark National Park and Preserve Bird List (NPS, 2000).

c. This study and incidental observations from other aerial and ground wildlife studies (e.g., landbird, waterbird), and Williamson and Peyton, 1962.

41.4 Waterbirds

41.4.1 Introduction

The results of waterbird surveys for 2004 and 2005 in the study area for the Cook Inlet drainages (study area) are presented in this section. Surveys for waterbirds focused on recording the distribution and abundance of all waterbirds—with an emphasis on waterfowl—observed using rivers during spring and fall migration and on Harlequin Ducks during breeding (pre-nesting and brood-rearing). The Iliamna Lake region of the northern Alaska Peninsula is an important migration route for many species of waterbirds (swans, geese, ducks, loons, shorebirds, and gulls) moving to and from breeding areas in western and northern Alaska (King and Lensink, 1971; Platte and Butler, 1995; Conant and Groves, 2005). Some species rely on coastal rivers during spring and fall because of the early availability of open water in spring and the persistence of open water during fall. Results of waterbird surveys of the marine environment (bays and mudflats) in the study area during spring and fall migration are presented in Chapter 44 (Marine Wildlife).

Harlequin Ducks are key indicator species for environmental health of productive riparian areas because they are sensitive to contaminants, changes in stream flow and siltation, and human disturbance, and they return to the same breeding streams in subsequent years, sometimes reusing nest sites (Bengtson, 1966; Fischer, 1998; Robertson and Goudie, 1999; Chubbs et al., 2000; Esler et al., 2002; Goudie and Jones, 2004; Zwiefelhofer, 2004). Harlequin Ducks are considered sensitive species in Alaska because they require specialized or unique habitats for breeding and are vulnerable to marine oil spills in their coastal wintering areas and to other contaminants in their riverine breeding areas (BLM, 2004).

41.4.2 Study Objectives

The objectives of the waterbird studies were to collect baseline data on the use of riverine habitats by waterbirds during the spring and fall seasons and on the occurrence of breeding Harlequin Ducks in the Cook Inlet drainages study area.

This study had two specific objectives:

- Determine the use of selected rivers by waterbirds during spring and fall migration.
- Determine breeding areas for Harlequin Ducks.

41.4.3 Study Area

The study area for staging waterbirds in the terrestrial habitats of the Cook Inlet drainages was comprised of selected large rivers that flow into Ilimana, Iniskin, Oil, and Chinitna bays (Figure 41.4-1). Surveys for Harlequin Ducks were conducted in some of the same river drainages as for staging waterbirds and, additionally, in some of the smaller drainages in the study area (Figures 41.4-2, 41.4-3, and 41.4-4). The 2005 survey area included the “Y Valley” between Iliamna and Iniskin bays.

The study area lies entirely in the Alaska Range ecological zone (Gallant et al., 1995). The terrain is generally mountainous with rocky and brush-covered upper slopes and white spruce and balsam poplar forests at lower elevations, particularly in the part of the study area between Iniskin and Chinitna bays.

Rivers surveyed in this area are slow, meandering streams through forest habitat. The Iniskin River is a broad, meandering river at the head of Iniskin Bay. The river channel cuts through mudflats in the lower section and is tidally influenced. At the southwestern extent of the study area (e.g., Cottonwood Bay), landscapes begin to transition more into the Alaska Peninsula Mountains ecological zone, where spruce forests are greatly reduced and shrub communities are more dominant (Gallant et al., 1995). Rivers around Cottonwood Bay, Iliamna Bay, and on the western side of Iniskin Bay are fast-flowing, with the upper reaches dominated by low to high scrub communities and tall shrubs or balsam poplar lining the drainages in the lower sections.

41.4.4 Previous Studies

Little research on waterbirds has been done in coastal riverine habitats of the study area (e.g., lower Cook Inlet in general, Chinitna Bay, Lake Clark National Park and Preserve, Katmai National Park and Preserve). Most studies conducted in or near Iliamna and Iniskin bays have focused on waterbirds in the marine environment (Erikson, 1977; Arneson, 1981; Agler et al., 1995; Bennett, 1996). On the Alaska Peninsula south of the study area, studies of spring and fall staging have been conducted in the Port Moller area (Gill et al., 1981), along the Naknek River (Scharf, 1993; Meixell and Savage, 2004; Oligschlaeger and Schuster, 2004; Schuster, 2004), and along the southwestern coast of Alaska from the Yukon-Kuskokwim Delta to Unimak Island (Mallek and Dau, 2000, 2002). Tundra Swan migratory behavior has been studied south of the study area between the Kvichak River and Unimak Island (Wilk, 1984, 1987, 1988; Dau and Sarvis, 2002, Doster, 2002). In Upper Cook Inlet, seasonal migration surveys for waterbirds have been conducted in coastal and marsh habitats from Redoubt Bay to the Palmer Flats (Butler and Gill, 1985, 1987; ADFG, 1994; Dugan and North, 1994; Eldridge, 1995).

Harlequin Ducks were noted on the Alaska Peninsula in the Katmai region (both Bristol Bay side and Pacific side) from the earliest biological surveys (Osgood, 1904; Cahalane, 1944; Gabrielson and Lincoln, 1959). Recent surveys for breeding Harlequin Ducks have been conducted in the Alaska Peninsula/Becharof National Wildlife Refuge (Savage, 2000) and Kodiak National Wildlife Refuge (Zwiefelhofer, 2004) south of the study area, and in Togiak National Wildlife Refuge (MacDonald, 2003), the Kilbuck Mountains (Morgart, 1998), and the southwest Kuskokwim Mountains (McCaffery and Harwood, 1996) west of the study area.

41.4.5 Scope of Work

The research and field work for this study were conducted during April through October 2004 and April through October 2005. The study was performed by Robert J. Ritchie, Ann M. Wildman, and Jennifer H. Boisvert of ABR, Inc., Fairbanks and Anchorage, according to the approach described in Chapter 9 of the *Draft Environmental Baseline Studies, Proposed 2004 Study Plan* (NDM, 2004) and the *Draft Environmental Baseline Studies, 2005 Study Plans* (NDM, 2005). The scope of work for waterbird studies in 2004 and 2005 included the following:

- Identifying rivers used by waterbirds during spring and fall migration.
- Surveying rivers for Harlequin Ducks during pre-nesting and brood-rearing.

41.4.6 Methods

41.4.6.1 Waterbird Spring and Fall Migration Surveys

Surveys using fixed-wing airplanes were flown for staging waterbirds during spring and fall migration in 2004 and 2005; in both years, surveys occurred every seven to 10 days. In 2004, four surveys were conducted in the spring between April 21 and May 22 (April 21 and May 3, 13, and 22), and five surveys were conducted in the fall between September 3 and October 21 (September 3, 13, and 23, and October 6 and 21). More surveys were conducted in 2005 than in 2004 to cover both the spring and fall migration periods more completely (NDM, 2005). In 2005, four surveys were conducted in the spring between April 24 and May 21 (April 24 and May 3, 15, and 21), and seven surveys were conducted in the fall between August 18 and October 11 (August 18 and 30; September 7, 13, and 29; and October 6 and 11).

Sections of rivers were selected (Figure 41.4-1) and assigned unique identification numbers prior to field surveys. Selection criteria included geographic features and possible development plans. The Iniskin River (the lower 8.6 kilometers) and an unnamed creek that flows into Iniskin Bay north of Sugarloaf Mountain (4.9 kilometers) were surveyed in 2004. The Iniskin River and the unnamed creek were not surveyed in 2005. Bowser and Fitz creeks (12.9 and 14.2 kilometers, respectively) between Iniskin and Chinitna bays were surveyed in 2005. In both years, Williams Creek (2.7 kilometers), which drains into the head of Iliamna Bay, was surveyed.

Standard operating procedures for both years called for one observer and a pilot to conduct surveys from a Piper PA18 Super Cub. Exceptions included the first migration survey in April 2004, which was conducted with two observers and a pilot in a Cessna 206, and two surveys in 2004 and one in 2005 which were conducted in a Robinson 44 helicopter. All surveys were flown at 60 meters above ground level and a speed of 100 to 145 kilometers per hour. During a survey, rivers were flown parallel to the river course to view waterfowl on the water and along the shore.

The observer recorded all data on a hand-held tape recorder, including the waterbody identification number; percent ice cover; the number, sex, and species of birds; and whether the birds were on the water, on the shore, or flying. Any nests and broods observed during the survey were recorded. Data from tapes were transcribed onto data sheets and entered in a computer database for analysis. Some waterfowl species are difficult to identify to species during aerial surveys (e.g., Trumpeter and Tundra swans, Lesser and Greater scaup, Common and Barrow’s goldeneyes, Common and Red-breasted mergansers), so in most cases, observers were unable to distinguish species within these species-pairs. Data were summarized by species, species-group, river segment, and date of survey. Waterbirds were categorized as waterfowl, shorebirds, or gulls.

41.4.6.2 Harlequin Duck Pre-nesting and Brood-rearing Surveys

One aerial survey for pre-nesting Harlequin Ducks in the study area was flown on May 28, 2004, and one survey was flown on May 26, 2005. A second pre-nesting survey was planned for 2005, but bad weather prevented it from occurring. No aerial surveys for brood-rearing Harlequin Ducks were flown in 2004 in the study area. Two aerial surveys for brood-rearing Harlequin Ducks were conducted in 2005—one on July 27 and one on August 12.

In 2004, researchers surveyed Williams Creek and an unnamed creek that flows into Iniskin Bay north of Sugarloaf Mountain for pre-nesting Harlequin Ducks (Figure 41.4-2). In 2005, four creeks were surveyed for pre-nesting Harlequin Ducks: Williams, Bowser, and Fitz creeks, and the left and lower branch of the creek in the Y Valley (Figure 41.4-3). During both brood-rearing surveys in 2005, all of the creeks surveyed during pre-nesting were surveyed again, and six additional creeks were added: three creeks that drain into Cottonwood Bay, two creeks that drain into upper Iniskin Bay south of Sugarloaf Mountain, and the east branch of the creek in the Y Valley (Figure 41.4-4).

All surveys were flown with two observers seated on the same side of a helicopter (Robinson 44, Hughes 500). Surveys were generally flown upriver at 45 meters above ground level and a speed of 65 kilometers per hour. The helicopter was positioned over the bank of the river to give the observers an unobstructed view of the entire width of the watercourse. In 2004, locations of only Harlequin Ducks were recorded, whereas in 2005, locations of all waterfowl were recorded to determine use of rivers by all waterfowl species.

For each observation, data recorded included a global positioning system (GPS) waypoint; river name; species; total number of birds in the group; numbers of pairs, males, and females; number of young; the birds' location (i.e., on the water, on shore, or flying); and stream flow (swift or placid). Also recorded for each stream was water clarity (clear, turbid, or glacial).

41.4.7 Results and Discussion

Sixteen species of waterbirds were observed during migration and breeding surveys in the study area (Table 41.4-1). Representatives from five species-groups were recorded: swans (1 species), ducks (10), waders (1), shorebirds (2), and gulls (2). Six species—Trumpeter Swan, Mallard, Green-winged Teal, Harlequin Duck, Common Merganser, and Red-breasted Merganser—were confirmed to breed in the study area based on the observation of a nest or a brood. Mew and Glaucous-winged gulls were confirmed breeders in the study area during boat-based surveys for marine wildlife (Chapter 44, Marine Wildlife). The remaining species observed were within their migration or breeding range (Bellrose, 1976), except for a Great Blue Heron observed on August 12, 2005, during the brood-rearing survey for Harlequin Ducks. An adult heron was standing along a creek south of Sugarloaf Mountain about 500 meters inland from Iniskin Bay. Although western Cook Inlet is outside of the breeding or migration range for Great Blue Herons, an annual post-breeding (late summer/fall) dispersal of single adults occurs from breeding areas near eastern Cook Inlet (Kenai Peninsula) to Kodiak Island (Gibson, pers. comm., 2007).

No waterbird species that is listed as federally endangered or threatened was observed in the Cook Inlet Drainages study area during surveys in 2004 and 2005 (USFWS, 2006). Some waterbird species that are not listed, however, are of conservation concern by governmental and non-governmental organizations because of apparent decreases in population abundance and/or population trends, or because of a lack of data on population abundance and/or population trends. Waterbird species of conservation concern are those that are classified by the U.S. Fish and Wildlife Service, the Bureau of Land Management, or the Alaska Department of Fish and Game, and/or are listed as of concern by non-governmental organizations focused on particular taxa (e.g., Partners in Flight, Alaska Shorebird Group) or by groups that use science extensively in conservation (e.g., Alaska Natural Heritage Program, Audubon Society). Species that occurred on at least two conservation lists are included as species of conservation concern. The rationale behind this approach to selecting species of conservation concern was that it relied primarily on information from groups of state and/or national experts in waterbird biology who used multiple criteria to determine the conservation status of each species.

Two species of waterbirds recorded during surveys in the study area were considered of conservation concern: Trumpeter Swan and Harlequin Duck. A discussion of the reasons why these two species are of conservation concern is presented in Chapter 17. Trumpeter Swans were observed infrequently and in small numbers along the Iniskin River and Bowser and Fitz creeks during spring and fall migration surveys (see Section 41.4.7.1). One Trumpeter Swan nest was found along Bowser Creek, and a brood, likely from that nest, was seen during fall migration surveys (see Section 41.4.7.1). Surveys for Harlequin Ducks found breeding pairs and broods in creeks in the Y Valley (see Section 41.4.7.2). Large number of Surf and Black scoters and Long-tailed Ducks staged in the marine environments of the Cook Inlet drainages (those results are presented in Chapter 44).

41.4.7.1 Waterbird Spring and Fall Migration Surveys

No waterbirds were seen during spring and fall migration surveys on Williams Creek in 2004 and 2005 or on an unnamed creek that flows into Iniskin Bay north of Sugarloaf Mountain in 2004. Both creeks were hard to survey from a fixed-wing aircraft because of their steep, narrow drainages and possibly some birds were missed.

The Iniskin River attracted numerous waterbirds during spring and fall, mostly waterfowl and gulls. During spring, dabbling ducks were observed in large numbers in the lower part of the river. Peak abundance occurred on May 3, 2004 (Table 41.4-2), when 488 dabbling ducks were recorded. (The number of dabbling ducks may have been high in late April also, but strong winds prevented a survey of the river.) Mallard was the most common dabbling duck species, followed by Northern Pintail, American Wigeon, Green-winged Teal, and Northern Shoveler. A few diving ducks were observed on the river, including scaup, Harlequin Duck, goldeneyes, and Common and Red-breasted mergansers. Other waterbirds observed during spring were one swan, one small shorebird, a flock of 25 medium-sized shorebirds, and one Glaucous-winged Gull.

During fall 2004 surveys along the Iniskin River, Mallards, Green-winged Teal, and mergansers were common during each survey from September 3 to October 6 (Table 41.4-2). The peak number of ducks occurred on September 13 when 434 birds were recorded. Gulls (mostly Glaucous-winged Gulls) were abundant in the upper part of the river where they fed on salmon carcasses. Gulls were most numerous on September 13 when 366 birds were counted. Opportunistic observations of waterbirds on the Iniskin River in 2005 indicated that it was used by large numbers of waterfowl during spring and fall migration.

Bowser and Fitz creeks, between Iniskin and Chinitna bays, were frozen and mostly snow-covered during the first two migration surveys in spring 2005. On the May 15 and 21 surveys, researchers observed small numbers of swans, goldeneyes, and mergansers (Table 41.4-3). A Trumpeter Swan nest was found in a wetland area adjacent to Bowser Creek (Figure 41.4-5) on May 21, and a brood was seen in the same area on August 18. The Iniskin Peninsula is part of the Cook Inlet survey unit flown by the U.S. Fish and Wildlife Service for Trumpeter Swans. Maps of swan locations from those surveys indicate that the Iniskin Peninsula, and in particular the area just inland from Oil Bay, has been occupied by Trumpeter Swans during the breeding season since at least 1995 (Conant et al., 2001).

During fall 2005 surveys of Bowser and Fitz creeks, small flocks of American Wigeon, Mallards, Northern Pintail, Green-winged Teal, and mergansers were observed (Table 41.4-3). Most of the waterfowl were observed on Bowser Creek; swans and mergansers were recorded only on Fitz Creek. American Wigeon, Mallard, Northern Pintail, and Green-winged Teal were observed on Bowser Creek in flocks of 15 to 40 birds on the surveys conducted on August 18 and 30, and September 13. A flock of 20 mergansers was observed there on October 11. Large flocks of hundreds of American Wigeon, Mallard, Northern Shoveler, Northern Pintail, and Green-winged Teal staged during spring and fall along the part of the river channel of Bowser Creek that cuts into the mudflats of Chinitna Bay. These counts were recorded as occurring in Chinitna Bay and are reported in Chapter 44, Marine Wildlife.

Migration surveys conducted in 1994 through 1996 along the Lake Clark National Park/Cook Inlet coastline similarly found dabbling ducks most numerous at river mouths and intertidal slough/mudflats (Bennett, 1996). In Chinitna Bay, the lower main stem and sloughs of Clearwater Creek, which is similar in size to the Iniskin River, accounted for 88 percent of the dabbling duck use in spring and fall (Bennett, 1996). Bennett (1996) reported that peak abundance of dabbling ducks occurred during late April and early September. Species composition of dabbling ducks was similar during spring and fall surveys in 1994 through 1996 (Bennett, 1996), and in 2004 and 2005 (this study). The Naknek River, south of the study area, is one of the most important spring waterfowl staging areas on the Alaska Peninsula because it often is the first ice-free large body of water (Schuster, 2004). In 2004 on the lower section of the Naknek River, dabbling duck counts peaked on April 13, and Mallards and Northern Pintails were the two most common dabbling ducks (Schuster, 2004). During fall surveys on the Naknek River in 1993, the phenology of individual species varied considerably, for example, two species of dabbling ducks—Northern Shovelers and Mallards—had peak counts in late August and mid-November, respectively (Scharf, 1993).

41.4.7.2 Harlequin Duck Pre-nesting and Brood-rearing Surveys

During pre-nesting surveys in 2004, no Harlequin Ducks were observed on the 7.9 kilometers of the two creeks surveyed; however, a pair was found in the marine waters of Cottonwood Bay (Figure 41.4-2; Table 41.4-4). In 2005, four drainages (totaling 34.6 kilometers) were surveyed during pre-nesting. One pair of Harlequin Ducks was observed in the lower section of the creek in the Y Valley (Figure 41.4-3; Table 41.4-4), for an overall linear density of 0.1 ducks per kilometer. During brood-rearing surveys in 2005, 10 drainages were surveyed for a total of 72.6 kilometers. One brood (female with two young) was observed on the east branch of the creek in the Y Valley (Figure 41.4-4; Table 41.4-4) on both the first survey (July 27) and the second (August 12). Another brood with three young was observed on the lower section of the creek in the Y Valley on August 12. The linear density of Harlequin Ducks during brood-rearing was 0.1 ducks per kilometer.

Linear densities of pre-nesting Harlequin Ducks in the study area were generally lower than those reported for surveys done within the past 10 years in other areas of southwest Alaska (Morgart, 1998; MacDonald, 2003; Zwiefelhofer, 2004). However, in a study of Harlequin Ducks in the Alaska Peninsula/Becharof National Wildlife Refuge, Savage (2000) reported that, because of the short length and steep gradient of many Pacific Coast streams, fewer ducks were found on streams draining into the Pacific Ocean than on those draining into large lakes (Becharof and Ugashik Lakes) or into Bristol Bay. Streams in the study area drain into the Pacific, whereas those studied in the Togiak National Wildlife Refuge and the Kilbuck Mountains drain into Bristol Bay or the Bering Sea. Linear densities in Togiak

National Wildlife Refuge ranged from 1.5 to 2.3 ducks per kilometer (MacDonald, 2003) and in the Kilbuck Mountains, from 1.3 to 1.7 ducks per kilometer (Morgart, 1998). The density within the Cook Inlet Drainages study area was calculated for all the rivers and creeks flown during the surveys, but Harlequin Ducks were found only on the creeks in the Y Valley. Recalculating densities for only those segments on which Harlequin Ducks actually occurred produced a linear density of 0.3 ducks per kilometer during pre-nesting. Similar densities (0.4 ducks per kilometer) were found in two watersheds surveyed in Kodiak National Wildlife Refuge in 2004 (Zwiefelhofer, 2004).

Densities of Harlequin Ducks were much lower and more variable during brood-rearing than during pre-nesting in the Togiak National Wildlife Refuge (MacDonald, 2003). Although the overall density of Harlequin Ducks was low in the Cook Inlet Drainages study area during brood-rearing, the density for the individual creek segments where ducks were actually seen was higher than during pre-nesting and was similar to those in Togiak National Wildlife Refuge (0.6 to 0.8 ducks per kilometer). On the two creeks in the Y Valley, for example, where seven ducks were seen (including two broods), the linear density was 0.6 ducks per kilometer. Mean brood size was 3.5 young per brood in the study area, which is within the range found in recent years in other areas of southwest Alaska: 3.1 to 4.0 young per brood in Kodiak National Wildlife Refuge (Zwiefelhofer, 2004), 3.4 to 3.8 young per brood in Togiak National Wildlife Refuge (MacDonald, 2003), 4.3 young per brood in Alaska Peninsula/Becharof National Wildlife Refuge (Savage, 2000), and 4.4 young per brood in the Kuskokwim Mountains (McCaffery, 1996).

All Harlequin Duck observations on creeks in the Cook Inlet Drainages study area were on clear-water streams. The pre-nesting pair on the lower section of the creek in the Y Valley was found in swift water, whereas the brood found on this same section of river was in placid water. The brood on the east branch of the creek in the Y Valley was found in swift water on both July 27 and August 12, 2005.

Fast, clear-water rivers with mid-stream islands are preferred nesting and brood-rearing habitats of Harlequin Ducks (Bengtson, 1966; Crowley, 1994; Robertson and Goudie, 1999). Harlequin Ducks forage entirely on animal prey, including stream invertebrates and fish roe (Bengtson, 1972; Vermeer, 1983; Fischer and Griffin, 2000). The presence of broods on the two creeks in the Y Valley indicates that, at present, the characteristics of these streams meet the requirements of breeding Harlequin Ducks. Harlequin Ducks are an indicator species of high-quality and productive riparian habitats (MacDonald, 2003; Zwiefelhofer, 2004).

During pre-nesting and brood-rearing surveys in 2005, other waterfowl observed on creeks were recorded. Mergansers (Common and Red-breasted) were the only other species observed during pre-nesting surveys, and they were observed on Bowser and Fitz creeks and the creeks in the Y Valley. During brood-rearing surveys, Common Mergansers broods were recorded on Bowser and Fitz creeks and on the lower section of the creek in the Y Valley (one, one, and three broods, respectively). One Red-breasted Merganser brood and one Mallard brood also were observed on the lower section of the creek in the Y Valley. One Mallard and one Green-winged Teal brood were found on the west branch of the creek in the Y Valley.

41.4.8 Summary

Researchers conducted aerial surveys in 2004 and 2005 to gather information on the distribution and abundance of waterbirds during spring and fall migration in the Cook Inlet drainages study area. The focus of the migration surveys was waterfowl (swans, geese, and ducks), but other waterbirds (loons, grebes, cormorants, shorebirds, gulls, and terns) also were recorded.

The Iniskin River was a popular staging location for dabbling ducks during spring and fall migration. Hundreds of dabblers were recorded near the lower section of the river, with the peak in spring occurring in late April/early May and the peak in fall occurring in mid-September. Diving ducks, some staging and some probably breeders, were observed all along the surveyed section of the Iniskin River. Hundreds of Glaucous-winged Gulls were found in the middle section of the river during fall, feeding on salmon carcasses.

Mergansers were found along Bowser and Fitz creeks during the breeding season, and a small flock staged on Fitz Creek in late fall. Dabbling ducks were not observed staging on the creeks in spring, mostly because the creeks did not thaw until mid-May, after dabblers had already migrated through the area. Small flocks of dabbling ducks were observed on Bowser Creek during fall. One Trumpeter Swan nest was found adjacent to Bowser Creek, and a brood was observed later in the same area.

Surveys for Harlequin Ducks were conducted during pre-nesting in 2004 and 2005 and during brood-rearing in 2005. A pair of ducks was observed in Cottonwood Bay in late May in 2004. In creeks in the Y Valley, a pair of ducks was found in late May in 2005, and broods were found in both late July and mid-August in 2005. Pairs and broods of Harlequin Ducks were not found in other creeks in the study area, but not all creeks were surveyed in both years. In 2004, only two creeks were surveyed, and no brood-rearing surveys were conducted. In 2005, six creeks surveyed during brood-rearing were not surveyed during pre-nesting. Other waterfowl species using creeks in the study area for brood-rearing included Mallard, Green-winged Teal, and Common and Red-breasted mergansers.

41.4.9 References

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41.4.10 Glossary

Phenology—the study of the seasonal timing of life cycle events (changes in plants and animals)

TABLES

TABLE 41.4-1
Waterbird Species Observed during Aerial Surveys, Cook Inlet Drainages, 2004 and 2005

Common Name	Scientific Name
Unidentified swan[a]	*Cygnus* spp.
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Unidentified scaup[b]	*Aythya* spp.
Harlequin Duck	*Histrionicus histrionicus*
Unidentified goldeneye[c]	*Bucephala* spp.
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Great Blue Heron	*Ardea herodias*
Unidentified small shorebird	—
Unidentified medium shorebird	—
Mew Gull	*Larus canus*
Glaucous-winged Gull	*Larus glaucescens*

Notes:

a. Trumpeter Swans (*Cygnus buccinator*) probably are the primary swan species in the Cook Inlet drainages study area, but Tundra Swans (*C. columbianus*) may be present.

b. Greater Scaup (*Athya marila*) probably are the primary scaup species in the Cook Inlet drainages study area, but Lesser Scaup (*A. affinis*) may be present.

c. Barrow's Goldeneye (*Bucephala islandica*) and Common Goldeneye (*B. clangula*) may be present.

TABLE 41.4-2
Numbers of Waterbirds (by Species-group and Species) Observed during Spring and Fall Migration Surveys of the Iniskin River, Cook Inlet Drainages, 2004

	Spring				Fall				
Species-Group/ Species	**Apr 21[a]**	**May 3**	**May 13**	**May 22[a]**	**Sep 3**	**Sep 13**	**Sep 23**	**Oct 6**	**Oct 21**
Waterfowl									
Unidentified swan	—	**1**	**0**	—	**0**	**0**	**0**	**0**	**0**
American Wigeon	—	**62**	**4**	—	**0**	**0**	**0**	**0**	**0**
Mallard	—	**200**	**24**	—	**9**	**260**	**143**	**72**	**0**
Northern Shoveler	—	**40**	**0**	—	**0**	**0**	**0**	**0**	**0**
Northern Pintail	—	**145**	**2**	—	**0**	**0**	**0**	**0**	**0**
Green-winged Teal	—	**41**	**8**	—	**131**	**85**	**56**	**19**	**0**
Unidentified scaup	—	**44**	**24**	—	**0**	**0**	**0**	**0**	**2**
Harlequin Duck	—	**0**	**2**	—	**0**	**0**	**0**	**0**	**0**
Unidentified goldeneye	—	**0**	**2**	—	**0**	**0**	**0**	**0**	**0**
Common Merganser	—	**4**	**0**	—	**0**	**0**	**0**	**5**	**0**
Red-breasted Merganser	—	**3**	**0**	—	**15**	**0**	**0**	**3**	**0**
Unidentified merganser	—	**19**	**0**	—	**63**	**89**	**22**	**14**	**8**
Unidentified duck	—	**0**	**9**	—	**0**	**0**	**27**	**0**	**6**
Waterfowl Total	—	**559**	**75**	—	**203**	**434**	**248**	**113**	**16**
Shorebirds									
Medium shorebird	—	**25**	**0**	—	**0**	**0**	**0**	**0**	**0**
Small shorebird	—	**0**	**1**	—	**0**	**1**	**0**	**0**	**0**
Shorebird Total	—	**25**	**1**	—	**0**	**1**	**0**	**0**	**0**
Gulls									
Mew Gull	—	**0**	**0**	—	**0**	**0**	**0**	**1**	**0**
Glaucous-winged Gull	—	**0**	**1**	—	**11**	**66**	**82**	**26**	**0**
Unidentified gull	—	**0**	**0**	—	**300**	**300**	**0**	**0**	**0**
Gull Total	—	**0**	**1**	—	**311**	**366**	**82**	**27**	**0**
TOTAL	—	**584**	**77**	—	**514**	**801**	**330**	**140**	**16**

Notes:

a. No surveys were flown of the Iniskin River because of air turbulence.

TABLE 41.4-3
Numbers of Waterbirds (by Species-group and Species) Observed during Spring and Fall Migration Surveys of Bowser and Fitz Creeks, Cook Inlet Drainages, 2005

	Spring				Fall						
Species-Group/ Species	Apr 24[b]	May 3[b]	May 15	May 21	Aug 18	Aug 30	Sep 7	Sep 13	Sep 29	Oct 6	Oct 11
Waterfowl[a]											
Unidentified swan	0	0	0	2	3	0	1	0	0	0	5
American Wigeon	0	0	0	0	20	0	0	0	0	0	0
Mallard	0	0	0	0	0	4	0	40	0	0	0
Northern Pintail	0	0	0	0	0	0	0	20	0	0	0
Green-winged Teal	0	0	0	0	15	30	0	20	0	0	0
Unidentified goldeneye	0	0	0	2	0	0	0	0	0	0	0
Unidentified merganser	0	0	12	4	13	0	0	0	0	0	20
WATERFOWL TOTAL	0	0	12	8	51	34	1	80	0	0	25

Notes:

a. Waterfowl was the only waterbird group observed on Bowser and Fitz creeks.

b. Creeks were mostly frozen and snow-covered.

TABLE 41.4-4
Numbers of Harlequin Ducks Observed during Pre-nesting and Brood-rearing Aerial Surveys, Cook Inlet Drainages, 2004 and 2005

	Pre-nesting				Brood-rearing[a]		
Year/ Location	Single Male	Single Female	Pairs	Total Birds	Females	Young	Total Birds
2004							
North Sugarloaf Mt. Creek	0	0	0	0	—	—	—
Williams Creek	0	0	0	0	—	—	—
Cottonwood Bay	0	0	1	2	—	—	—
TOTAL	0	0	1	2	—	—	—
2005							
Bowser Creek	0	0	0	0	0	0	0
Cottonwood Creeks[b]	—	—	—	—	0	0	0
Fitz Creek	0	0	0	0	0	0	0
South Sugarloaf Mt. Creeks[b]	—	—	—	—	0	0	0
Williams Creek	0	0	0	0	0	0	0
Y Valley Lower Branch	0	0	1	2	1	3	4
Y Valley East Branch[b]	—	—	—	—	1	2	3
Y Valley West Branch	0	0	0	0	0	0	0
TOTAL	0	0	1	2	2	5	7

Notes:

a. No brood-rearing surveys were conducted in 2004.

b. No pre-nesting surveys were conducted at this location.

FIGURES

THE pebble PARTNERSHIP

Figure 41.4-1
Rivers Surveyed for Staging Waterbirds during Spring and Fall Migration, Cook Inlet Drainages, 2004 and 2005

Legend

Year Surveyed

2004

2005

2004 and 2005

Existing Road

Miles 0 1 2 3 4 5

Kilometers 0 2 4 6 8

N

Scale 1:240,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-4-1_WtrbrdMigrRiv_CI_PLP_EBD_v01.mxd	Date: June 28, 2010
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THE pebble PARTNERSHIP

Figure 41.4-2 Harlequin Duck Pre-nesting Locations, Cook Inlet Drainages, 2004

Legend

- Pair
- Survey Stream
- Existing Road

Miles: 0 1 2 3 4 5

Kilometers: 0 2 4 6 8

Scale 1:240,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-4-2_HADUPreNest04_CI_PLP_EBD_v01.mxd	Date: June 28, 2010
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THE pebble PARTNERSHIP

Figure 41.4-3
Harlequin Duck
Pre-nesting Locations,
Cook Inlet Drainages,
2005

Legend

Pairs (# pairs >1)

Male

Survey Stream

Existing Road

Miles: 0 1 2 3 4 5

Kilometers: 0 2 4 6 8

Scale 1:260,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-4-3_HADUPreNest05_CI_PLP_EBD_v01.mxd	Date: June 28, 2010
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Figure 41.4-4
Harlequin Duck Brood-rearing Locations, Cook Inlet Drainages, 2005

Legend

- Brood
- Survey Stream
- Existing Road

Miles: 0 1 2 3 4 5
Kilometers: 0 2 4 6 8
Scale 1:260,000
N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-4-4_HADUBrdRear05_CI_PLP_EBD_v01.mxd	Date: Sept. 28, 2010
Version: 1	Author: ABR-AZC

Figure 41.4-5. Swan Nesting Locations, Cook Inlet Drainages, 2005

Legend

- Nest
- Existing Road

Miles: 0 1 2 3 4 5

Kilometers: 0 2 4 6 8

N

Scale 1:240,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-4-5_SwanNesting_CI_PLP_EBD_v01.mxd	Date: June 28, 2010
Version: 1	Author: ABR-AZC

41.5 Breeding Landbirds and Shorebirds

41.5.1 Introduction

The results of the 2005 breeding landbird and shorebird surveys in the Cook Inlet drainages study area are presented in this section. This work focuses on assessing the baseline conditions for breeding landbirds and shorebirds in the Cook Inlet drainages study area. Only observations of landbirds and shorebirds are reported here. Observations of waterbirds and raptors recorded during the survey effort for landbirds and shorebirds are reported in the waterbird and raptor sections of this chapter (Sections 41.4 and 41.3, respectively). The occurrence of nonbreeding shorebirds in intertidal habitats in the Cook Inlet drainages study area is reported in Chapter 44 (marine wildlife). This report summarizes the work conducted during the 2005 breeding season, documenting the landbird and shorebird species observed, their abundance, and their use of the mapped terrestrial habitats in the study area. The mapping of wildlife habitats in the study area is presented in Section 41.1 (habitat mapping and habitat-value assessments).

41.5.2 Study Objectives

The primary objective of this work was to collect baseline data on breeding landbirds and shorebirds in the Cook Inlet drainages study area. Researchers recorded all species observed in the field, paying special attention to species of conservation concern. The specific objectives of this study were to:

- Identify the assemblage of landbird and shorebird species that use the study area during the breeding season.
- Quantify the abundance of each species.
- Determine which habitats in the study area are important for breeding landbirds and shorebirds.

41.5.3 Study Area

The Cook Inlet drainages study area for 2005 consisted of a 610-meter-wide corridor of roughly 19 kilometers in length (Figure 41.5-1). The generally linear study area runs from the western shore of Iniskin Bay north of Knoll Head and then up the eastern shore of Iliamna Bay to the pass that separates the Cook Inlet drainages from the Bristol Bay drainages to the west. The study area also incorporated the Y-shaped valley (Y Valley) north and west of Knoll Head. The total Cook Inlet drainages study area (including the Y Valley) comprises approximately 21 square kilometers.

The Cook Inlet drainages study area is principally coastal. The study area includes steep coastal mountain slopes, two creek valleys, and the upper portion of Iliamna Bay. The terrain in the area is generally mountainous with fast-flowing creeks, but a gently sloping area occurs in the Y Valley north of Knoll Head. Subalpine areas of white spruce (*Picea glauca*) woodland with upland dwarf scrub and graminoid-herb openings are common in the creek valleys. A few areas of balsam poplar (*Populus balsamifera*) forests and mixed white spruce/balsam poplar forests also occur in the creek valleys. Some more well-drained areas at the higher elevations are dominated by upland dwarf scrub. Occasional, small forest openings dominated by wetter graminoid and scrub bog vegetation occur. However, the area is strongly dominated by tall scrub vegetation, which occurs extensively on upland slopes, in the lowlands, and in riverine areas. These areas are dominated by closed stands of Sitka alder (*Alnus sinuata*) and thinleaf alder (*A. tenuifolia*).

41.5.4 Previous Studies

A search of the published and unpublished biological literature for the region surrounding the Cook Inlet drainages study area did not reveal any studies on breeding landbirds and shorebirds that apply directly to the study area. Baseline biological data for the Pebble Deposit area collected by Cominco in the early 1990s did not address landbirds or shorebirds. A number of avifaunal studies, however, have been conducted within a broader region surrounding the Cook Inlet drainages study area (Figure 41.5-2) and provide general information on the relative abundance and distribution of breeding landbirds and shorebirds. Previous studies have been conducted in the Bristol Bay region (Hurley, 1931, 1932); the Iliamna Lake area (Williamson and Peyton, 1962); the northern Alaska Peninsula (Osgood, 1904; Gibson, 1970; Gill et al., 1981); the Katmai region (Cahalane, 1944, 1959); Katmai and Lake Clark national parks (Bennett, 1996a, 1996b; Gill et al., 1999; Gill and Tibbitts, 2003; Ruthrauff et al., 2007); Ugashik Bay (Gibson and Kessel, 1983); the Becharof Lake area (Dewhurst et al., 1996a; Moore and Leeman, 1996); the Mother Goose Lake area (Dewhurst et al., 1996b; Egan and Adler, 2001); or consider birds broadly in southwestern Alaska (Kessel and Gibson, 1978; Bennett, 1996c). None of these studies, however, are directly comparable to surveys conducted in the Cook Inlet drainages study area because of differences in survey methods, timing of surveys, habitats surveyed, field effort (e.g., number of point-counts conducted), and/or geographical or elevational extent of the surveys. The most important of these factors is variability in the survey coverage of different habitats, which can result in a different set of landbird and shorebird species being recorded in different studies, in addition to differences in abundance within species. The conclusions that can be drawn from comparisons of the work done in the Cook Inlet drainages study area to these other regional studies therefore are limited.

41.5.5 Scope of Work

Surveys for breeding landbirds and shorebirds were conducted in the Cook Inlet drainages study area during June 2005. Charles T. Schick and Jennifer H. Boisvert, of ABR, Inc., Anchorage, Alaska, conducted the study according to the approach described in *Draft Environmental Baseline Studies, 2005 Study Plans* (NDM, 2005). This work included the following activities:

- Allocating point-count sample plots based on aerial photosignature type, which allowed sampling of all the important breeding-bird habitats in the study area.
- Performing early morning point-counts at each sample location.
- Recording habitat-use information (when possible) for all species observed at each point-count location.
- Recording observations and habitat-use information for less common species and/or species of conservation concern when in transit between sample locations.

41.5.6 Methods

41.5.6.1 Field Surveys and Habitat-use Analyses

Surveys for breeding landbird and shorebirds in the Cook Inlet drainages study area followed the methods outlined in the 2005 study plan (NDM, 2005). Researchers used variable circular-plot point-count methods (Ralph et al., 1995; Buckland et al., 2001). These survey methods were designed primarily to detect singing male passerine birds defending territories and have become the standard method for surveying breeding landbirds in remote terrain in Alaska (USGS, 2006). These methods also have recently been adopted for inventories of breeding shorebirds in Alaska (Ruthrauff et al., 2007; ASG, 2006).

Researchers selected point-count locations for sampling among the available habitats in the study area using true-color aerial photography from Aero-Metric (September 2004). A formal stratified-random sampling of points within each vegetation or habitat type, using a geographic information system (GIS), would have been preferable, but this was not possible given the lack of a fine-scale vegetation or habitat map for the area at the time the surveys were conducted. A completely random allocation of sample points across the survey area also could have been attempted, but this would have resulted in an over-sampling of the most common habitat types and an under-sampling, or omission, of less common habitats. Instead, researchers used the prominent photosignatures (i.e., habitat types) on the aerial photography as the sampling strata. Sample points were located in a haphazard fashion within each photosignature (by a vegetation ecologist with no knowledge of bird-habitat associations) subject to the restriction of a minimum distance of 500 meters between sample points. This sampling scheme resulted in a selection of point-count locations that was unbiased with respect to the distribution of birds on the landscape. Sample points were selected to satisfy two criteria:

- To allocate points within all prominent photosignatures evident on the aerial photography.
- To establish an adequate spatial representation of points within the Cook Inlet drainages study area.

The first criterion was established to help meet one of the primary objectives of this work, which was to assess habitat associations of breeding landbirds and shorebirds. For the second criterion, sample points were spread broadly across the study area and replicated within each photosignature to try and capture any spatial variability in habitat use by breeding birds.

Researchers conducted point-counts in the Cook Inlet drainages study area from June 3 through 12, 2005. Survey timing was selected to coincide with the peak breeding period for landbirds in southwestern Alaska. Many shorebirds start breeding activities earlier in May in southwestern Alaska, but very few shorebirds were observed and the area in general (other than intertidal coastal areas for Oystercatchers) does not provide much open habitat for breeding shorebirds.

All point-count surveys were conducted between 0430 and 1600 hours, but most frequently between 0500 and 1400 hours. Point-counts were continued into the afternoon to collect additional data on habitat use and make the best use of field-day hours. Although some species, especially landbirds, often reduce their vocal activity after midday (particularly on warm days), this was not an important issue for the primary survey objective, because researchers were less interested in the absolute numbers of birds recorded than in collecting data on bird-habitat associations. The survey protocols were not designed for a long-term bird-monitoring program.

Hand-held global positioning system (GPS) receivers were used to locate preselected survey points in the field. Sample points were accessed by helicopter and on foot. All helicopter activity occurred at least 100 meters from sample points, and observers waited at least two minutes after arriving at a sample location before starting the count. Point-counts were conducted in standard 10-minute intervals (Ralph et al., 1995). Four categories of observations were made during the point-count survey efforts, and the habitats being used by the bird(s) were recorded whenever possible for each category:

- **Focal observations** were of birds recorded during the point-count period using the habitat that was being sampled by the researchers directly at the point-count location.
- **Nonfocal observations** were of birds recorded during the point-count period but using different habitats, which were typically adjacent to the focal habitat being sampled directly. Focal and nonfocal observations combined were used to assess abundance for landbirds and shorebirds in this study.
- **Incidental observations** were recorded at the point-count location but were not made during the point-count period (birds were either seen before or after the count period). Incidental observations were recorded primarily to collect more data on the less common species. These observations were not systematically made and were not used to assess abundance in this study.
- **In-transit observations** were made as researchers moved between point-count locations. These nonsystematic observations were primarily of less common species and/or observations of nests, defensive behavior indicative of the presence of a nest, or fledglings being tended by an adult(s).

During the point-counts, all species observed either visually or aurally were recorded. Any individual birds counted at multiple points (e.g., birds conducting territorial displays that could be seen or heard from two adjacent point-count locations) were recorded only once at the point where they were initially detected. Habitat types were recorded for as many bird observations as possible. Habitat types were categorized in the field using combinations of physiography classes and the Level IV vegetation types of *The Alaska Vegetation Classification* (Viereck et al., 1992).

Observations were categorized into estimated distance categories (Rosenstock et al., 2002) to allow the possible calculation of bird densities with distance analyses (Laake et al., 1994; Buckland et al., 2001). Distance-estimation training for each field crew member was conduced over a period of two days before the field surveys and laser rangefinders were regularly used in the field to calibrate distance estimates and determine distances when possible.

41.5.6.2 Species of Conservation Concern

To determine which landbird and shorebird species occurring in the Cook Inlet drainages study area currently are listed as species of conservation concern, researchers consulted bird-conservation lists from federal and state management agencies, conservation organizations, and bird working-groups that directly address the conservation concerns for Alaskan birds (Table 41.5-1). In general, the goal in preparing these lists is not to identify those species treated formally by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act, rather it is to identify species that currently may be common but for which there are concerns about the long-term viability of their populations (see below). The bird-conservation lists reviewed were those that considered Alaskan birds specifically and were published as of 2007: the USFWS's *Birds of Conservation Concern* (USFWS, 2002); the Bureau of Land Management's *Alaska Threatened, Endangered, and Sensitive Species List* (BLM, 2005); the U.S. Forest Service's *Alaska Region Sensitive Species List* (USFS, 2002), the Alaska Department of Fish and Game's *Species of Special Concern* (ADF&G, 1998) and *Comprehensive Wildlife Conservation Strategy* (ADF&G, 2006), Audubon Alaska's *Watchlist 2005* (Stenhouse and Senner, 2005), the Alaska Natural Heritage Program's *Birds Tracking List* (AKNHP, 2007), the Boreal Partners in Flight Working Group's *Landbird Conservation Plan for Alaska Biogeographic Regions* (BPIFWG, 1999), and the Alaska Shorebird Group's *Conservation Plan for Alaska Shorebirds* (ASG, 2004). Additional information on bird species of conservation concern in the Cook Inlet drainages study area is presented in Chapter 45 (Threatened and Endangered Species and Species of Conservation Concern – Cook Inlet Drainages).

The eight bird-conservation lists reviewed here variously considered several criteria related to population persistence in Alaska that included information on population trend, population size, known threats during the breeding and nonbreeding seasons, and range size and dispersion both during breeding and nonbreeding. On some lists (e.g., ADF&G, 2006), additional species-selection criteria were used that included information on known health concerns, the incidence of mortality, endemism (to Alaska), sensitivity to disturbance, the lack of information on population status, questionable taxonomy, representativeness (for habitat use), and international importance for monitoring. Some listing groups similarly considered monitoring concerns, both globally and in the state, when selecting species (BPIFWG, 1999) and others considered specialized habitat requirements (BLM, 2005). Of the eight lists reviewed, seven lists consider landbirds and seven lists consider shorebirds. On some of these lists, species were quantitatively ranked and categorized by conservation class (e.g., high, moderate, or low concern), while on other lists, a single category of conservation concern was used. Alaska stewardship or monitoring concerns also were considered on some lists for those cases in which a large proportion of the global population of the species resides in Alaska. For this study, in an attempt to identify those species for which there is genuine conservation concern, as opposed to stewardship concern or moderate or low conservation concern, researchers selected species of conservation concern using two criteria:

- First, the species had to be listed in the highest conservation category(ies), if applicable, within the classification system used (species of moderate or low concern were not considered). On those lists in which a single conservation class was used, however, all species of conservation concern occurring in the study area were considered.
- Second, the species had to be listed as of conservation concern on at least two of the lists that considered landbirds and shorebirds in Alaska. This criterion helped to eliminate species of moderate or low concern that only occur on a single bird-conservation list.

Additional research reports were reviewed for each species of conservation concern recorded in the Cook Inlet drainages study area to provide background ecological information on the reasons for conservation concern (see Section 41.5.7).

41.5.7 Results and Discussion

Point-count locations were spread, as much as possible, along the full length of the linear transportation corridor and through the Y Valley to try to adequately sample the spatial variability in habitat types occurring within the study area (Figure 41.5-1). Researchers conducted 51 point-counts in the Cook Inlet drainages study area in 2005 and recorded 456 individual birds. Sixteen birds were recorded as incidental and in-transit observations in the study area (Appendix 41.5A).

Breeding landbirds and/or shorebirds were recorded in 10 of the 13 habitat types sampled in the study area (Table 41.5-2); 21 terrestrial and freshwater aquatic wildlife habitats were mapped in the study area (see Section 41.1), but not all mapped habitats were sampled with point-count surveys. Many of the unsampled habitats were in alpine physiographic areas, or were riverine or lacustrine waterbody types not targeted for point-count surveys.

The number of bird species observed in each habitat (species richness) ranged from 0 to 13 and the average number of birds recorded per count in each habitat ranged from 0.0 to 6.7 (these figures were calculated using focal observations only; Table 41.5-2). The most productive breeding habitats, in terms of bird abundance (using focal observations per point count as the measure of abundance), were Upland and Lowland Spruce Forest, Upland and Lowland Moist Mixed Forest, Upland Moist Tall Alder Scrub, and Riverine Tall Alder or Willow Scrub. In each of these four habitats, more than five birds were observed per count; in the remaining habitats, three or fewer birds were recorded per count. One habitat (Upland Moist Tall Alder Scrub) supported the highest numbers of breeding-bird species (13) while five other habitats (Upland and Lowland Spruce Forest, Upland and Lowland Moist Mixed Forest, Riverine Tall Alder or Willow Scrub, Upland Moist Low Willow Scrub, and Lowland Wet Graminoid–Shrub Meadow) supported intermediate numbers of species (six to nine). The remaining habitats supported one or two species each. Many of the habitat types with the highest species richness also had high bird abundance, as measured by observations per count (Table 41.5-2).

41.5.7.1 Species Richness and Abundance by Species-Group

Including the incidental and in-transit observations and additional observations made during nearshore marine wildlife surveys (Chapter 44), researchers identified 32 species of landbirds and shorebirds, combined, in the Cook Inlet drainages study area during the breeding season in 2005 (Tables 41.5-3 and 41.5-6). Of these 32 species, most (30 species) were landbirds, all of which were passerines. The remaining two species were shorebirds.

Considering only those 27 species observed systematically during point-count surveys in the study area, passerines were clearly the dominant group with 25 species recorded; the only other species-groups observed were corvids (one species) and shorebirds (one species) (Figure 41.5-3).

In terms of abundance, warblers were by far the most abundant birds observed during point-counts in the study area (nearly 220 individuals; Figure 41.5-4). Sparrows and allies (including juncos), and thrushes also were common. Very few shorebirds or passerines in the six other species-groups (flycatchers, corvids, chickadees, dippers, kinglets, and finches) were observed. It is likely all the abundant and common species using the area were identified during the surveys, although some uncommon or rare species using the area may not have been detected. It is well known that the occurrence and numbers of both landbirds and shorebirds can fluctuate widely among years at any one location, and some rare species may go undetected in a single year of study.

Comparisons of the numbers of landbird and shorebird species observed in the Cook Inlet drainages study area can be made to numbers documented in other studies on the upper Alaska Peninsula and in western

Cook Inlet (Figure 41.5-2). To standardize the comparisons, the numbers of species are restricted to only those observations made during point-counts. In the Cook Inlet drainages study area, 26 landbird species and one shorebird species were recorded, and in Lake Clark National Park (LCNP), 46 landbird and 14 shorebird species were recorded (Ruthrauff et al., 2007). The Cook Inlet drainages study area is just south of LCNP and encompasses habitats similar to those found in LCNP (e.g., dwarf scrub, low and tall scrub, and coastal meadow habitats). However, the LCNP surveys were conducted over a more extensive geographical area and elevational gradient (e.g., open upland areas, alpine habitats, and forests were included), whereas in the Cook Inlet drainages study area the sampling was concentrated in tall scrub habitats (Table 41.5-2). The greater habitat diversity sampled in LCNP likely accounts for the greater bird-species richness found there. In Katmai National Park (KNP) on the upper Alaska Peninsula, 35 landbird and 11 shorebird species were documented during point-count surveys (Ruthrauff et al., 2007). As with the surveys by Ruthrauff et al. (2007) in LCNP, the KNP surveys were conducted over a large geographic area that included more habitats than were sampled in the Cook Inlet drainages study area. The greater habitat diversity sampled in KNP is a likely explanation for the greater number of shorebird and landbird species recorded there relative to the Cook Inlet drainages study area. In two other point-count-based studies of breeding birds conducted on the upper Alaska Peninsula, 19 to 20 landbird species and four to seven shorebird species were recorded (at Becharof Lake in Becharof National Wildlife Refuge and at Mother Goose Lake in the Alaska Peninsula National Wildlife Refuge, respectively [Moore and Leeman, 1996; Dewhurst et al., 1996b; Egan and Adler, 2001]). The roughly similar numbers of breeding landbird species observed in these two Alaska Peninsula studies and in the Cook Inlet drainages study area likely are due to the study area sizes being relatively small in all cases and because a relatively small set of habitat types were surveyed in each study. More shorebird species were recorded in the Alaska Peninsula studies than in the Cook Inlet drainages study area, undoubtedly because of a greater prevalence of open habitats suitable for breeding shorebirds at the Alaska Peninsula sites.

41.5.7.2 Landbird Occurrence

Researchers observed 26 landbird species (Table 41.5-3) and calculated a mean of 8.8 birds per location during the point-count surveys in the Cook Inlet drainages study area in 2005. Most birds observed were assumed to be nesting in the area, based on observations of nests or repeated observations of display activities, territorial behavior, or alarm/skulking reactions typical of nesting landbirds. Landbird species richness and abundance in the Cook Inlet drainages study area were lower than in the transportation-corridor study area in the Bristol Bay drainages (Section 16.11), where 42 landbird species were observed during point-counts and a mean of 11.6 birds per sample point was calculated. The lower species richness and abundance of birds in the Cook Inlet drainages study area undoubtedly is because of the reduced habitat diversity and the smaller extent of productive open-forest habitat types there.

The most frequently observed species (those with at least 25 point-count observations) were considered to be abundant in the Cook Inlet drainages study area. Six species (Wilson’s Warbler, Golden-crowned Sparrow, Yellow Warbler, Hermit Thrush, Orange-crowned Warbler, and Savannah Sparrow) were considered abundant (Table 41.5-4). Four of these species (Wilson’s Warbler, Golden-crowned Sparrow, Yellow Warbler, and Hermit Thrush) were especially abundant and accounted for 67 percent of the point-count observations. Two other landbird species (Fox Sparrow and Gray-cheeked Thrush) were observed less frequently (between 10 and 15 point-count observations) in the Cook Inlet drainages study area and were considered common in the area. The other landbird species observed in the Cook Inlet drainages study area were recorded fewer than 10 times on point-counts and were considered uncommon. The average occurrences of landbird species in the Cook Inlet drainages study area ranged from 0.020 for each of nine species to 1.824 for the Wilson's Warbler (Table 41.5-4).

In Table 41.5-5, landbird abundance in the Cook Inlet drainages study area is contrasted with landbird abundance found in other similar studies of breeding birds conducted on the upper Alaska Peninsula and in western Cook Inlet. Average-occurrence values are used to standardize abundance data across studies in which different numbers of point-counts were conducted. Point-count-based studies of landbirds were conducted at Mother Goose Lake in the Alaska Peninsula National Wildlife Refuge (Dewhurst et al., 1996b; Egan and Adler, 2001), at Becharof Lake in Becharof National Wildlife Refuge (Moore and Leeman, 1996), and in Katmai and Lake Clark national parks (Ruthrauff et al., 2007) (Figure 41.5-2). Differences in the sizes of study areas and the habitats surveyed among these studies make the comparisons approximate, but with these caveats in mind, the comparisons are still instructive.

Of the six most commonly recorded landbird species in the Cook Inlet drainages study area (Wilson's Warbler, Golden-crowned Sparrow, Yellow Warbler, Hermit Thrush, Orange-crowned Warbler, and Savannah Sparrow), five species also were among the six most common landbird species found at both Mother Goose Lake and Becharof Lake on the Alaska Peninsula. These similar results likely are due to the preponderance of tall-scrub habitats (and especially tall alder) both in the Cook Inlet drainages study area and at the two Alaska Peninsula sites.

In KNP, there was less similarity in the rankings of common landbird species when compared to the Cook Inlet drainages study area; only half (three) of the six most common landbird species found in the Cook Inlet drainages study area were among the six most common species recorded in KNP. And in LCNP, there were even fewer similarities in the rankings of abundance of landbirds when compared to the Cook Inlet drainages study area. For example, only one of the six most common landbird species in the Cook Inlet drainages study area was among the six most common landbird species found at LCNP. These dissimilar results from KNP and LCNP likely are because there was not a focus on sampling lower elevation tall-scrub habitats in KNP and LCNP (sampling was conducted across broad regions in both parks and encompassed numerous habitat types), whereas lower elevation tall-scrub habitats are strongly dominant in the Cook Inlet drainages study area.

Across all species, the average-occurrence values at Becharof Lake and Mother Goose Lake compared favorably with the values in the Cook Inlet drainages study area (Table 41.5-5). Average occurrences for landbirds in the Cook Inlet drainages study area ranged from 0.020 to 1.824, at Becharof Lake they ranged from 0.020 to 1.879, and at Mother Goose Lake from 0.021 to 3.057. The next highest average-occurrence value at Mother Goose Lake (below the exceptionally high 3.057 for Wilson's Warblers) was 1.723. Average occurrences across all landbird species at KNP ranged from 0.002 to 0.868 and at LCNP ranged from 0.003 to 0.628 compared to a range of 0.020 to 1.824 in the Cook Inlet drainages study area. The lower abundances in KNP and LCNP most likely are due to many more points being surveyed in KNP and LCNP (468 and 417 in KNP and LCNP, respectively, and compared to 51 in the Cook Inlet drainages study area) and to the point-count sampling in KNP and LCNP being conducted over a far greater geographical area and elevational range than that in the Cook Inlet drainages study area. This will cause a "dilution effect" in which the average occurrences calculated for each species in the KNP and LCNP studies will be reduced by the inclusion of a larger number of point-counts conducted in habitats where, for example, many scrub-adapted landbird species do not occur (e.g., forest and alpine areas). In contrast, in the Cook Inlet drainages study area, there likely is a "concentration effect" occurring because many of the same habitats are repeatedly surveyed (by design).

Of the four landbird species of conservation concern recorded in the Cook Inlet drainages study area (Olive-sided Flycatcher, Gray-cheeked Thrush, Varied Thrush, and Blackpoll Warbler; see Sections 41.5.7.4 and 41.5.7.8 below for more information on these species), only the Gray-cheeked Thrush was recorded also at Becharof Lake and Mother Goose Lake on the upper Alaska Peninsula (Table 41.5-5). (The ranges of two of the other three species—the exception is Varied Thrush—do not extend southward onto the Alaska Peninsula.) Gray-cheeked Thrushes were more abundant at the two Alaska Peninsula lake sites than in the Cook Inlet drainages study area and the species was not recorded in KNP. Varied Thrushes, however, were recorded in KNP. Gray-cheeked Thrushes and two of the other three landbird species of conservation concern recorded in the Cook Inlet drainages study area also were recorded in LCNP. These three species, however, had lower average-occurrence values in LCNP, and as discussed above, this lower abundance likely is an artifact of the larger number of points sampled and the greater geographical extent and greater elevational range surveyed in LCNP. In contrast, Varied Thrush was found to be more abundant in LCNP than in the Cook Inlet drainages study area, likely reflecting a greater focus on sampling forested habitats in LCNP (forests are rare in the Cook Inlet drainages study area).

41.5.7.3 Landbird Habitat Associations

Average-occurrence figures (numbers of birds observed per point-count), derived from focal observations only, were used to evaluate habitat use of landbirds in the Cook Inlet drainages study area. Using an average measure of abundance for each species in each habitat eliminates the bias that occurs in comparing total numbers of birds observed among habitats when unequal numbers of point-counts are conducted in different habitats (see Section 41.5.6.1).

In the Cook Inlet drainages study area, the greatest numbers of breeding landbird species were found in tall-scrub habitats. Thirteen (68 percent) of the 19 landbird species recorded as focal observations were observed in Upland Moist Tall Alder Scrub (Table 41.5-6). Tall-scrub habitats are extremely common in the Cook Inlet drainages study area and elsewhere in Alaska such habitats have been found to provide suitable breeding habitat for many landbird species, particularly warblers (Williamson and Peyton, 1962; Kessel, 1998; Andres et al., 1999; Benson, 2004). Other habitats that supported intermediate numbers of breeding landbird species were Upland and Lowland Spruce Forest (nine species), and Upland and Lowland Moist Mixed Forest, Upland Moist Low Willow Scrub, Riverine Tall Alder or Willow Scrub, and Lowland Wet Graminoid–Shrub Meadow (six species each). The other sampled bog, meadow, dwarf-scrub, and barren habitats in the study area supported fewer landbird species (one to two; Table 41.5-6).

The six abundant species in the study area (Wilson's Warbler, Golden-crowned Sparrow, Yellow Warbler, Hermit Thrush, Orange-crowned Warbler, and Savannah Sparrow) tended to be found most commonly in either forest or tall-scrub habitats as would be expected from their habitat preferences, although Savannah Sparrows also were found commonly in bog and meadow habitats (Table 41.5-6). The two common species in the study area (Fox Sparrow and Gray-cheeked Thrush) were found most commonly in tall-scrub habitats. The observed habitat use varied among landbird species, but nearly all species that were observed in tall-scrub habitats used Upland Moist Tall Alder Scrub most commonly (Table 41.5-6). The exception was Gray-cheeked Thrush, which was observed more frequently in Riverine Tall Alder or Willow Scrub.

As expected for abundant bird species, the six abundant species in the study area used the largest number of habitats (four to seven habitats per species; Table 41.5-6). The two common species in the area used a smaller set of habitats (two to three) and the uncommon species used fewer habitats (one to two).

An assessment of the value of all available habitats in the Cook Inlet drainages study area for a subset of landbird species that are of conservation concern or management concern (for sport and subsistence hunting) is presented in Section 41.1.

41.5.7.4 Landbird Species of Conservation Concern

No landbirds that breed in Alaska are listed as federally endangered or threatened, or as proposed or candidate species (USFWS, 2006). A number of landbird species in the state, however, are listed as conservation-priority species by government agencies and non-governmental organizations that consider bird-conservation issues in Alaska and several of these species occur in the Cook Inlet drainages study area (Table 41.5-1). Using the criteria defined for this study to assess which species are of conservation concern (Section 41.5.6.2), researchers determined that four (13 percent) of the 30 landbird species recorded in the Cook Inlet drainages study area are of conservation concern for Alaska (Table 41.5-1, Figure 41.5-3). Nesting was confirmed for one of these four species (Gray-cheeked Thrush), but not for the other three (Olive-sided Flycatcher, Varied Thrush, and Blackpoll Warbler). The conservation concerns for these four species are outlined below.

Olive-sided Flycatcher

An analysis of data from the North American Breeding Bird Survey (BBS) for Olive-sided Flycatchers showed a consistent and widespread decline of 3.5 percent per year between 1966 and 2004 in breeding populations across the U.S. and Canada (Sauer et al., 2005). This suggests the worldwide population may have declined by as much as 70 percent over that period. In Alaska, breeding populations declined 2.3 percent per year between 1980 and 2004 (Sauer et al., 2005). Likely mortality factors on the breeding grounds in boreal forests in North America include deforestation, including salvage harvests, and forest-fire suppression activities (Altman and Sallabanks, 2000). Habitat alteration in the Cook Inlet area of Alaska, where human development is most active, is of concern (BPIFWG, 1999). The bulk of the mortality in this species, however, is suspected to occur on the wintering grounds (BPIFWG, 1999; Altman and Sallabanks, 2000). Olive-sided flycatchers winter in Central America and most extensively in South America where intensive tropical deforestation is suspected to be the primary factor driving the population declines. This species is considered highly vulnerable to the effects of deforestation during winter because of its preference for undisturbed tropical broadleaf forest (Petit et al., 1995). Olive-sided Flycatcher is listed as a species of conservation concern for Alaska on five of the seven agency or working group lists that consider landbird conservation issues in the state (Table 41.5-1).

Olive-sided Flycatcher was considered an uncommon species in the Cook Inlet drainages study area, where it was recorded only once during point-counts (a nonfocal observation in Upland and Lowland Spruce Forest) and once as an incidental sighting (Table 41.5-4; Appendix 41.5A). Habitat use by this species in the study area is assessed further in Section 41.1.

Gray-cheeked Thrush

The Gray-cheeked Thrush is of conservation concern because there are indications, from an analysis of BBS data, that declines in breeding populations in eastern North America occurred from 1978 to 1988 (Sauer and Droege, 1992). A longer time-period analysis of BBS data for Canada only, where this species is more common, shows a statistically significant population decline of 8.8 percent per year from 1967 to 2000 (although these results apply to only a small portion of the breeding range; Dunn, 2005). Similar population trend data for Alaska are not available (Sauer et al., 2005). On their tropical wintering grounds (largely South America east of the Andes), this species is considered vulnerable to deforestation of broadleaf forests (Petit et al., 1993). Because Gray-cheeked Thrushes breed largely in relatively remote and undisturbed boreal forest and arctic environments where population threats are minimal, it is possible that declines in breeding populations may be driven primarily by the effects of tropical deforestation on the wintering grounds. Still, there are concerns that breeding populations in Alaska should be maintained because a large percentage of the species' global breeding range is concentrated in Alaska (BPIFWG, 1999). Gray-cheeked Thrush is listed as a species of conservation concern for Alaska on four of the seven agency or working group lists that consider landbird conservation issues in the state (Table 41.5-1).

Gray-cheeked Thrushes were considered common in the Cook Inlet drainages study area (Table 41.5-4) and were most frequently recorded in Riverine Tall Alder or Willow Scrub; they were less common in Upland Moist Tall Alder Scrub (Table 41.5-6; see also Section 41.1).

Varied Thrush

The Varied Thrush is considered vulnerable to forestry management practices because its primary habitat is coniferous forests on the North American west coast and in Alaska (BPIFWG 1999). The species also breeds less commonly in tall-scrub habitats in areas of western Alaska where forests are not present. BBS data indicate statistically significant declines of 1.1% per year for Varied Thrush populations in western North America from 1980 to 2004; no significant declines have been found in Alaskan populations over the same time period (Sauer et al., 2005). The primary concern for this species in Alaska is focused on monitoring and maintaining breeding populations in the state (BPIFWG 1999). A few Varied Thrushes winter in southcentral Alaska coastal forests, but most winter in coastal forests of southeastern Alaska, British Columbia, and in coastal and inland forests in several western lower 48 states where they also are considered vulnerable to deforestation activities (Luke, 2000). The Varied Thrush is listed as a species of conservation concern for Alaska on two of the seven agency or working group lists that consider landbird conservation issues in the state (Table 41.5-1).

Varied Thrushes were found to be uncommon in the Cook Inlet drainages study area (Table 41.5-4); the species was recorded only once during point-counts in an undetermined habitat type. Habitat use by Varied Thrushes in the study area is assessed in Section 41.1.

Blackpoll Warbler

An analysis of BBS data for Blackpoll Warblers showed breeding populations across North America declining 9.5 percent per year between 1980 and 2004 (Sauer et al., 2005). Population numbers had increased from 1966 to 1979, but declined thereafter (Sauer et al., 2005). An analysis of data from Alaska also indicated a decline in breeding populations, in this case 3.0 percent per year between 1980 and 2004 (Sauer et al., 2005). On the wintering grounds in South America, the species is considered highly vulnerable to the removal of tropical forests (Petit et al., 1993, 1995), and there are suggestions that heavy mortality can occur during trans-oceanic fall-migration flights because of tropical storms (Butler, 2000). Because Blackpoll Warblers in Alaska breed largely in relatively remote and undisturbed boreal forest regions (areas with few population threats), the implication is that declines in breeding populations may be driven primarily by the combined effects of mortality during migration and tropical deforestation on the wintering grounds. Conservation concerns in Alaska are that breeding populations should be maintained because a large percentage of the species' global breeding range is concentrated in Alaska (BPIFWG, 1999). The Blackpoll Warbler is listed as a species of conservation concern for Alaska on five of the seven agency or working group lists that consider landbird conservation issues in the state (Table 41.5-1).

Blackpoll Warbler was considered an uncommon species in the Cook Inlet drainages study area (Table 41.5-4) where it was recorded only once during point-counts in Upland Moist Tall Alder Scrub. Habitat use by this species in the study area is assessed further in Section 41.1.

41.5.7.5 Shorebird Occurrence

Shorebirds were much less common in the Cook Inlet drainages study area than in the two study areas in the Bristol Bay drainages (Sections 16.5 and 16.11). In the Cook Inlet drainages study area, during point-counts only, researchers observed only one shorebird species (Black Oystercatcher; Table 41.5-7) and calculated a mean of only 0.1 birds observed per point-count. By contrast, in the transportation-corridor study area in the Bristol Bay drainages, five shorebird species were observed during point-counts, and a mean of 0.3 birds per point-count was calculated. In the mine study area, 14 shorebird species were observed during point-counts, and a mean of 1.1 birds per point-count was calculated. The paucity of breeding shorebirds in the Cook Inlet drainages study area undoubtedly is because of the lack of extensive open habitats such as moist graminoid meadows, scrub bogs, and upland dwarf scrub, which are often used by breeding shorebird species in southwestern Alaska (ASG, 2004).

Seven Black Oystercatchers were detected on three occasions during point-counts, and the species had an average-occurrence value of 0.137 (Table 41.5-8). A second shorebird species, Short-billed Dowitcher, also was recorded in the Cook Inlet drainages study area, but this species was observed only once as an incidental sighting. Because fewer than 10 observations of both of these species were recorded during the survey efforts, both species were considered uncommon in the study area during the breeding season. However, specific surveys of the intertidal habitats of shorebirds were not conducted in this study, and Black Oystercatchers were noted as common during nearshore surveys for marine wildlife (although they nested in small numbers; see Chapter 44). Similarly, although dowitchers apparently do not breed in the Cook Inlet drainages study area, they were found to use intertidal areas in the Cook Inlet marine study area during spring migration (Chapter 44).

41.5.7.6 Shorebird Habitat Associations

Black Oystercatcher was the only shorebird species recorded in a mapped habitat type in the Cook Inlet drainages study area. All seven birds were recorded as nonfocal observations along the rocky coastline near Knoll Head. This is a marine intertidal habitat (see Section 41.1); additional observations of shorebirds in the marine littoral environment are reported in Chapter 44 (marine wildlife).

41.5.7.7 Shorebird Species of Conservation Concern

No shorebirds that breed in Alaska are listed as federally endangered or threatened, or as proposed or candidate species (USFWS, 2006). Shorebirds are, however, of increasing conservation concern worldwide as many species have relatively low reproductive rates, small effective population sizes, and declining population numbers (IWSG, 2003). Shorebirds also are vulnerable to habitat alteration, especially at migratory staging sites where large numbers of birds congregate (Brown et al., 2001; ASG, 2004). A number of shorebird species in Alaska are listed as species of conservation concern by government agencies and non-governmental organizations that consider bird-conservation issues in the state and some of these species occur in the Cook Inlet drainages study area (Table 41.5-1). Using the criteria defined for this study to assess which species are of conservation concern (Section 41.5.6.2), researchers determined that both shorebird species recorded in the Cook Inlet drainages study area are of conservation concern for Alaska (Table 41.5-1, Figure 41.5-3). Neither species (Black Oystercatcher or Short-billed Dowitcher) nests in the study area, but they use intertidal habitats nearby. The conservation concerns for these two species are outlined below.

Black Oystercatcher

The Black Oystercatcher is listed as a species of conservation concern because of a small population size, limited distribution, and susceptibility to impacts, especially during breeding. Black Oystercatchers use a very restricted set of habitats (coastal rocky shorelines and cobble beaches) and are vulnerable to impacts from oil spills, natural predators, and increasingly, human disturbance during nesting and brood rearing (Andres, 1997; Poe, 2003). This species is widely dispersed and characterized by a small overall population (currently estimated at approximately 8,900 birds), of which more than 60 percent breed in Alaska (ASG, 2004). Black Oystercatchers have strong fidelity to breeding areas, a low reproductive rate, and heavy offspring mortality, which makes them vulnerable to local impacts (Andres, 1997; 1998). However, without disturbance, local population numbers can quickly increase (Murphy and Mabee, 2000; Gill et al., 2004). The Black Oystercatcher is listed as a species of conservation concern for Alaska on six of the seven agency or working group lists that consider shorebird conservation issues in the state (Table 41.5-1).

Seven Black Oystercatchers were observed in the Cook Inlet drainages study area and the species was considered uncommon (Table 41.5-7). Specific surveys of the intertidal habitats of shorebirds, however, were not conducted in this study. During nearshore surveys for breeding seabirds (see Chapter 44), Black Oystercatchers were considered relatively common in rocky intertidal habitats.

Short-billed Dowitcher

Significant population declines in the central Canadian race of Short-billed Dowitcher, *Limnodromus griseus griseus*, have been documented, and declines also likely have occurred in the eastern Canadian race, *L. g. hendersoni* also (Donaldson et al., 2000; Brown et al., 2001; Jehl et al., 2001). Adequate trend data are lacking for the Alaskan subspecies, *L. g. caurinus*, to conduct a formal population-trend analysis, but declining numbers on nonbreeding surveys have researchers concerned that populations of this subspecies as well may have declined, especially over the past decade (ASG, 2004). The world population of *L. g. caurinus* is thought to be relatively low—estimated at approximately 75,000 birds (Morrison et al., 2006), all of which breed in Alaska. Habitat loss on the wintering grounds on the Atlantic and Pacific coasts of North, Central, and South America, and especially at migration stopover sites, also is of concern

(Brown et al., 2001; ABC and NAS, 2007). The Short-billed Dowitchers is listed as a species of conservation concern for Alaska on three of the seven agency or working group lists that consider shorebird conservation issues in the state (Table 41.5-1).

Short-billed Dowitcher was considered an uncommon species in the Cook Inlet drainages study area during the breeding season where it was observed only once as an incidental sighting near the coast. Dowitchers were found to be common, however, in intertidal areas in the Cook Inlet marine study area during spring migration (see Chapter 44).

41.5.7.8 Synopsis of Species of Conservation Concern

Based on the species-selection criteria outlined above in Section 41.5.6.2, six (19 percent) of the 32 landbird and shorebird species observed in the Cook Inlet drainages study area are considered species of conservation concern for Alaska. Three of the four landbird species (Olive-sided Flycatcher, Gray-cheeked Thrush, and Blackpoll Warbler) were found to be more abundant in the Cook Inlet drainages study area than in nearby LCNP (these three species were not recorded in KNP) (Ruthrauff et al., 2007). As noted above, however, this result likely is an artifact of the larger number of points sampled and the greater geographical extent and greater elevational range surveyed in LCNP. The fourth landbird species of conservation concern, Varied Thrush, was recorded more frequently in LCNP (and in KNP) than in the Cook Inlet drainages study area, likely reflecting a greater focus on sampling forested habitats in LCNP and KNP (forests are rare in the Cook Inlet drainages study area). Only one of the four landbird species of conservation concern (Gray-cheeked Thrush) was recorded in other studies on the upper Alaska Peninsula south of KNP (Dewhurst et al., 1996b; Moore and Leeman, 1996; Egan and Adler, 2001). Gray-cheeked Thrushes, however, were more common in the Alaska Peninsula studies than in the Cook Inlet drainages study.

The two shorebird species of conservation concern recorded in the Cook Inlet drainages study either were observed only in the marine environment (Black Oystercatcher) or were represented by a single incidental sighting (Short-billed Dowitcher).

41.5.8 Summary

Researchers conducted a total of 51 point-counts and recorded 456 individual birds in the Cook Inlet drainages study area in 2005. Including incidental and in-transit observations and additional observations made during nearshore marine wildlife surveys, researchers identified 30 landbird species and two shorebird species in the Cook Inlet drainages study area. Using point-count survey data, researchers calculated a mean of 8.8 landbirds and 0.1 shorebirds per count in the study area. Six landbird species (Wilson’s Warbler, Golden-crowned Sparrow, Yellow Warbler, Hermit Thrush, Orange-crowned Warbler, and Savannah Sparrow) were considered to be abundant in the study area. Open habitats suitable for breeding shorebirds are rare in the Cook Inlet drainages study area, and shorebirds were recorded in low abundance (0.1 observations per point-count). The two shorebird species observed (Black Oystercatcher and Short-billed Dowitcher) were considered uncommon in the area. Warblers were by far the most abundant bird species-group recorded (nearly 220 individuals), and Wilson’s Warblers, in particular, were very abundant in the study area. Wilson’s Warblers accounted for more than 20 percent of the bird observations in the Cook Inlet drainages study area. Sparrows and thrushes also were common bird species-groups.

Landbirds were recorded in 10 of the 13 wildlife-habitat types sampled in the study area and shorebirds were recorded only in marine intertidal areas (not directly sampled with point-counts). Species richness of landbirds observed in each of the sampled habitats ranged from 0 to 13, and bird abundance within each habitat sampled ranged from 0.0 to 6.7 birds per count. The most productive habitat type in the study area for breeding landbirds, in terms of species richness, was Upland Moist Tall Alder Scrub. Five other habitats (Upland and Lowland Spruce Forest, Upland and Lowland Moist Mixed Forest, Upland Moist Low Willow Scrub, Riverine Tall Alder or Willow Scrub, and Lowland Wet Graminoid–Shrub Meadow) supported intermediate numbers of breeding landbird species. The least productive habitats for landbirds, in terms of species richness, were bog, meadow, dwarf-scrub, and barren habitat types. Four forest and scrub habitats (Upland and Lowland Spruce Forest, Upland and Lowland Moist Mixed Forest, Upland Moist Tall Alder Scrub, and Riverine Tall Alder or Willow Scrub) were the most productive in terms of bird abundance and supported five or more birds per point-count. Individual landbird species often used a range of different habitats forest, scrub, bog, and meadow habitats with the more common species using a larger set of habitats than the uncommon species. Shorebirds were observed only near the coast and were not observed to be breeding in terrestrial habitats in the study area.

Six (19 percent) of the 32 landbird and shorebird species observed in the Cook Inlet drainages study area are considered species of conservation concern for Alaska. These include both of the shorebird species recorded (Black Oystercatcher and Short-billed Dowitcher) and four of the landbirds (Olive-sided Flycatcher, Gray-cheeked Thrush, Varied Thrush, and Blackpoll Warbler).

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41.5.10 Glossary

Avifauna—the set of bird species occurring in a particular geographic region

Corvid—any bird species in the family Corvidae, which includes the jays, crows, and ravens

Graminoid—grass and grass-like plants (including sedges and rushes)

Passerine—collectively, the group of songbirds or perching birds in the taxonomic order Passeriformes

Photosignature—a combination of color and texture on an aerial photo indicative of a particular vegetation or land-cover type

Physiography—in the limited sense used here, a categorization of landforms/topographic regions into classes, which are based largely on the geomorphological forces shaping the landforms in those areas (e.g., alpine, subalpine, upland, lowland, riverine [see below], and coastal)

Riverine—associated with rivers and streams, and landscape features developed from the actions of rivers and streams

TABLES

TABLE 41.5-1
Landbird and Shorebird Species of Conservation Concern[a] for Alaska Observed in the Cook Inlet Drainages Study Area, 2005, and Listing Status

Species	USFWS[b]	BLM[c]	USFS[d]	ADF&G[e]	Audubon[f]	AKNHP[g]	BPIF[h]	ASG[i]
Olive-sided Flycatcher	Species of conservation concern	Sensitive species	—[j]	Species of special concern and featured species for conservation	Species at risk	—	Priority species for conservation	—
Gray-cheeked Thrush	—	Sensitive species	—	Species of special concern	—	Vulnerable	Priority species for conservation	—
Varied Thrush	—	—	—	Featured species for conservation	—	—	Priority species for conservation	—
Blackpoll Warbler	Species of conservation concern	Sensitive species	—	Species of special concern and featured species for conservation	Species at risk	—	Priority species for conservation	—
Black Oystercatcher	Species of conservation concern	—	Sensitive species	Featured species for conservation	Species at risk	Imperiled	—	Species of high conservation concern
Short-billed Dowitcher	Species of conservation concern	—	—	—	—	—	—	Species of high conservation concern

Notes:

a. See Section 41.5.6.2 for definition of species of conservation concern.

b. U.S. Fish and Wildlife Service (USFWS), Birds of Conservation Concern (USFWS, 2002); species shown are listed in either, or both, of two Bird Conservation Regions (BCRs) (western Alaska and northwestern interior forest) because the Cook Inlet drainages study area is near the border between the two BCRs.

c. Bureau of Land Management (BLM), Alaska Threatened, Endangered, and Sensitive Species List (BLM, 2005).

d. U.S. Forest Service (USFS), Alaska Region Sensitive Species List (USFS, 2002).

e. Alaska Department of Fish and Game (ADF&G), Species of Special Concern (ADG&G, 1998) and Comprehensive Wildlife Conservation Strategy (ADF&G, 2006).

f. Audubon Alaska WatchList 2005 (Stenhouse and Senner, 2005).

g. Alaska Natural Heritage Program (AKNHP), Birds Tracking List (AKNHP, 2007); state listings only; the highest conservation ranking for either the breeding or nonbreeding season is shown; secure and apparently secure rankings (roughly equivalent to low and moderate conservation-concern classes) are not shown.

h. Boreal Partners in Flight Working Group (BPIFWG), Landbird Conservation Plan for Alaska Biogeographic Region (BPIFWG, 1999).

i. Alaska Shorebird Group (ASG), A Conservation Plan for Alaska Shorebirds (ASG, 2004); species of high concern only are listed.

j. A dash indicates the species was not listed by that group or its ranking fell below the conservation-status threshold for inclusion (see notes above).

TABLE 41.5-2
Number of Point-counts, Number of Focal Observations, Focal Observations per Count, and Species Richness Recorded in Mapped Habitat Types[a] during Point-count Surveys for Landbirds and Shorebirds in the Cook Inlet Drainages Study Area, 2005

Aggregated Habitat Type	No. of Point-counts	No. of Focal Observations[b]	Focal Observations per Count	Species Richness[c]
Alpine Dry Barrens	0	0	0.0	0
Alpine Moist Dwarf Scrub	0	0	0.0	0
Upland Dry Barrens	1	1	1.0	1
Upland Dry Dwarf Shrub–Lichen Scrub	1	0	0.0	0
Upland Moist Dwarf Scrub	5	1	0.2	1
Upland Moist Low Willow Scrub	3	9	3.0	6
Upland Moist Tall Alder Scrub	19	110	5.8	13
Upland Moist Tall Willow Scrub	1	0	0.0	0
Upland and Lowland Spruce Forest	3	20	6.7	9
Upland and Lowland Moist Mixed Forest	3	17	5.7	6
Rivers and Streams	0	0	0.0	0
Rivers and Streams (Anadromous)	0	0	0.0	0
Riverine Barrens	2	0	0.0	0
Riverine Wet Graminoid–Shrub Meadow	0	0	0.0	0
Riverine Low Willow Scrub	0	0	0.0	0
Riverine Tall Alder or Willow Scrub	4	21	5.3	6
Lakes and Ponds	0	0	0.0	0
Lowland Sedge–Forb Marsh	0	0	0.0	0
Lowland Ericaceous Scrub Bog	2	1	0.5	1
Lowland Wet Graminoid–Shrub Meadow	4	9	2.3	6
Coastal Graminoid–Forb Meadow	3	3	1.0	2

Notes:

a. See Section 41.1 for information on wildlife habitat mapping in the transportation-corridor, Bristol Bay drainages study area.

b. Focal observations were recorded in the habitat being sampled; observations recorded in adjacent habitats are not shown.

c. Species richness calculated only for focal observations in each habitat.

TABLE 41.5-3
Landbird Species Observed during Point-count Surveys and Incidentally at Point-count Locations[a], with Additional Observations Made during Nearshore Marine Wildlife Surveys, Cook Inlet Drainages Study Area, 2005

Avian Group	Common Name	Scientific Name
Corvids	Black-billed Magpie	*Pica pica*
	Common Raven[b]	*Corvus corax*
Passerines	Olive-sided Flycatcher *	*Contopus cooperi*
	Tree Swallow[c]	*Tachycineta bicolor*
	Violet-green Swallow[c]	*Tachycineta thalassina*
	Cliff Swallow[c]	*Petrochelidon pyrrhonota*
	Black-capped Chickadee	*Poecile atricapillus*
	American Dipper	*Cinclus mexicanus*
	Ruby-crowned Kinglet	*Regulus calendula*
	Gray-cheeked Thrush *	*Catharus minimus*
	Swainson's Thrush	*Catharus ustulatus*
	Hermit Thrush	*Catharus guttatus*
	American Robin	*Turdus migratorius*
	Varied Thrush	*Ixoreus naevius*
	Orange-crowned Warbler	*Vermivora celata*
	Yellow Warbler	*Dendroica petechia*
	Yellow-rumped Warbler	*Dendroica coronata*
	Blackpoll Warbler *	*Dendroica striata*
	Northern Waterthrush	*Seiurus noveboracensis*
	Wilson's Warbler	*Wilsonia pusilla*
	American Tree Sparrow	*Spizella arborea*
	Savannah Sparrow	*Passerculus sandwichensis*
	Fox Sparrow	*Passerella iliaca*
	Song Sparrow	*Melospiza melodia*
	Lincoln's Sparrow	*Melospiza lincolnii*
	White-crowned Sparrow	*Zonotrichia leucophrys*
	Golden-crowned Sparrow	*Zonotrichia atricapilla*
	Dark-eyed Junco	*Junco hyemalis*
	Pine Grosbeak	*Pinicola enucleator*
	Common Redpoll	*Carduelis flammea*

Notes:

a. No additional landbird species were observed in transit between point-count locations.

b. Incidental observations only.

c. Cliff Swallows recorded nesting on coastal cliffs, other swallows in flight during nearshore marine wildlife surveys (see Chapter 44).

d. Denotes a species of conservation concern for Alaska (see Table 41.5-1).

TABLE 41.5-4
Number, Percent of Total Observations, and Average Occurrence of Landbird Species Observed during Point-count Surveys, Cook Inlet Drainages Study Area, 2005

Avian Species	No.	%	Avg. Occurrence[a] (*n*=51)
Wilson's Warbler	93	20.7	1.824
Golden-crowned Sparrow	76	16.9	1.490
Yellow Warbler	72	16.0	1.412
Hermit Thrush	59	13.1	1.157
Orange-crowned Warbler	44	9.8	0.863
Savannah Sparrow	29	6.5	0.569
Fox Sparrow	15	3.3	0.294
Gray-cheeked Thrush	10	2.2	0.196
Black-billed Magpie	6	1.3	0.118
Common Redpoll	6	1.3	0.098
Yellow-rumped Warbler	5	1.1	0.098
Lincoln's Sparrow	5	1.1	0.098
Unidentified Passerine	5	1.1	0.098
Ruby-crowned Kinglet	4	0.9	0.078
American Robin	2	0.5	0.039
Northern Waterthrush	2	0.5	0.039
Unidentified Warbler	2	0.5	0.039
Song Sparrow	2	0.5	0.039
Dark-eyed Junco	2	0.5	0.039
Olive-sided Flycatcher	1	0.2	0.020
Black-capped Chickadee	1	0.2	0.020
American Dipper	1	0.2	0.020
Swainson's Thrush	1	0.2	0.020
Unidentified (Catharus) Thrush	1	0.2	0.020
Varied Thrush	1	0.2	0.020
Blackpoll Warbler	1	0.2	0.020
American Tree Sparrow	1	0.2	0.020
White-crowned Sparrow	1	0.2	0.020
Pine Grosbeak	1	0.2	0.020

Notes:

a. Average occurrence = number of bird detections divided by *n* (number of point-counts conducted).

TABLE 41.5-5
Average Occurrence[a] of Landbird Species Observed in the Cook Inlet Drainages Study Area, 2005, and in other Studies in Southwestern Alaska in which Off-road Point-count Surveys Were Conducted

Landbird Species	Mother Goose Lake (*n*=141)[b]	Becharof Lake (*n*=99)[c]	Katmai NP (n=468)[d]	Lake Clark NP (*n*=379)[d]	This study (*n*=51)
Wilson's Warbler	3.057	1.808	0.485	0.261	1.824
Golden-crowned Sparrow	0.915	1.879	0.868	0.628	1.490
Yellow Warbler	0.993	0.727	0.051	0.098	1.412
Hermit Thrush	1.589	1.455	0.415	0.297	1.157
Orange-crowned Warbler	0.993	1.091	0.295	0.077	0.863
Savannah Sparrow	0.255	1.707	0.239	0.175	0.569
Fox Sparrow	0.603	0.394	0.575	0.374	0.294
Gray-cheeked Thrush	0.482	0.414		0.034	0.196
Black-billed Magpie	0.007		0.011	0.038	0.118
Common Redpoll	1.723	1.182	0.222	0.568	0.118
Yellow-rumped Warbler			0.143	0.362	0.098
Lincoln's Sparrow			0.002	0.007	0.098
Ruby-crowned Kinglet			0.015	0.170	0.078
American Robin	0.745	0.152	0.291	0.300	0.039
Northern Waterthrush			0.004	0.019	0.078
Song Sparrow					0.039
Dark-eyed Junco			0.115	0.369	0.039
Olive-sided Flycatcher				0.012	0.020
Black-capped Chickadee	0.064	0.081	0.009	0.007	0.020
American Dipper					0.020
Swainson's Thrush				0.012	0.020
Varied Thrush			0.041	0.192	0.020
Blackpoll Warbler				0.002	0.020
American Tree Sparrow		0.182	0.327	0.360	0.020
White-crowned Sparrow	0.163		0.226	0.288	0.020
Pine Grosbeak	0.170		0.006	0.002	0.020
Willow Ptarmigan		0.192	0.135	0.168	
Rock Ptarmigan			0.135	0.084	
White-tailed Ptarmigan			0.004	0.012	
Downy Woodpecker	0.014				
American Three-toed Woodpecker			0.009	0.007	
Alder Flycatcher	0.376	0.030			
Say's Phoebe				0.005	
Northern Shrike	0.057	0.020	0.002	0.002	
Gray Jay			0.009	0.034	
Common Raven	0.028		0.058	0.072	
Horned Lark			0.085	0.103	

Landbird Species	**Mother Goose Lake (*n*=141)[b]**	**Becharof Lake (*n*=99)[c]**	**Katmai NP (n=468)[d]**	**Lake Clark NP (*n*=379)[d]**	**This study (*n*=51)**
Tree Swallow	0.759	0.071	0.038	0.026	
Violet-green Swallow				0.005	
Bank Swallow	0.021				
Boreal Chickadee			0.006	0.017	
Golden-crowned Kinglet				0.002	
Northern Wheatear			0.004	0.019	
American Pipit		0.141	0.415	0.353	
Bohemian Waxwing				0.012	
Lapland Longspur		0.182	0.041	0.043	
Snow Bunting		0.020	0.122	0.082	
Rusty Blackbird				0.007	
Gray-crowned Rosy-Finch			0.009	0.005	
White-winged Crossbill				0.005	
Pine Siskin				0.002	

Notes:

a. Average occurrence = number of bird detections divided by *n* (number of point-counts conducted).

b. Off-road point-count data collected in 1996 and 2000 at Mother Goose Lake in the Alaska Peninsula National Wildlife Refuge; data were combined from Dewhurst et al. (1996b) and Egan and Adler (2001).

c. Off-road point-count data collected in 1996 at Becharof Lake in the Becharof National Wildlife Refuge (Moore and Leeman, 1996).

d. Off-road point-count data collected in 2004–2006 in Katmai and Lake Clark national parks (Ruthrauff et al., 2007).

TABLE 41.5-6
Average Occurrence Figures[a] for Landbirds in Mapped Terrestrial and Freshwater Aquatic Wildlife Habitat Types, Cook Inlet Drainages Study Area, 2005

Species	Alpine Dry Barrens	Alpine Moist Dwarf Scrub	Upland Dry Barrens	Upland Dry Dwarf Shrub–Lichen Scrub	Upland Moist Dwarf Scrub	Upland Moist Low Willow Scrub	Upland Moist Tall Alder Scrub	Upland Moist Tall Willow Scrub	Upland and Lowland Spruce Forest	Upland and Lowland Moist Mixed Forest	Rivers and Streams	Rivers and Streams (Anadromous)	Riverine Barrens	Riverine Wet Graminoid–Shrub Meadow	Riverine Low Willow Scrub	Riverine Tall Alder or Willow Scrub	Lakes and Ponds	Lowland Sedge–Forb Marsh	Lowland Ericaceous Scrub Bog	Lowland Wet Graminoid–Shrub Meadow	Coastal Graminoid–Forb Meadow
	n=0	*n*=0	*n*=1	*n*=1	*n*=5	*n*=3	*n*=19	*n*=1	*n*=3	*n*=3	*n*=0	*n*=0	*n*=2	*n*=0	*n*=0	*n*=4	*n*=0	*n*=0	*n*=2	*n*=4	*n*=3
Black-billed Magpie									0.333											0.250	
Ruby-crowned Kinglet									0.667												
Gray-cheeked Thrush							0.105									0.500					
Swainson's Thrush							0.053														
Hermit Thrush							0.895		0.333							0.750				0.250	
American Robin							0.053														
Orange-crowned Warbler						1.000	0.421		1.333	0.667											
Yellow Warbler						0.667	1.526		1.000	0.667						1.250					
Yellow-rumped Warbler										0.333											
Blackpoll Warbler							0.053														
Northern Waterthrush							0.053														
Wilson's Warbler			1.000			0.333	1.474		0.667	2.667						1.000				0.500	
American Tree Sparrow							0.053														
Savannah Sparrow							0.053		0.667	1.000									0.500	0.750	0.667
Fox Sparrow							0.368									0.250					0.333
Song Sparrow						0.333															
Lincoln's Sparrow						0.333														0.250	
Golden-crowned Sparrow					0.200		0.684		1.333	0.333						0.500				0.250	
Dark-eyed Junco						0.333			0.333												

Notes:

a. Average occurrence = number of bird detections divided by *n* (number of point-counts conducted); only focal observations in each habitat are included (see Section 41.5.6.1, Field Surveys and Habitat-use Analyses)

TABLE 41.5-7
Shorebird Species Observed during Point-count Surveys and Incidentally at Point-count Locations, Cook Inlet Drainages Study Area, 2005

Common Name	Scientific Name
Black Oystercatcher *	*Haematopus bachmani*
Short-billed Dowitcher[a] *	*Limnodromus griseus*

Notes:

a. Incidental observation only.

b. Denotes a species of conservation concern for Alaska (see Table 41.5-1).

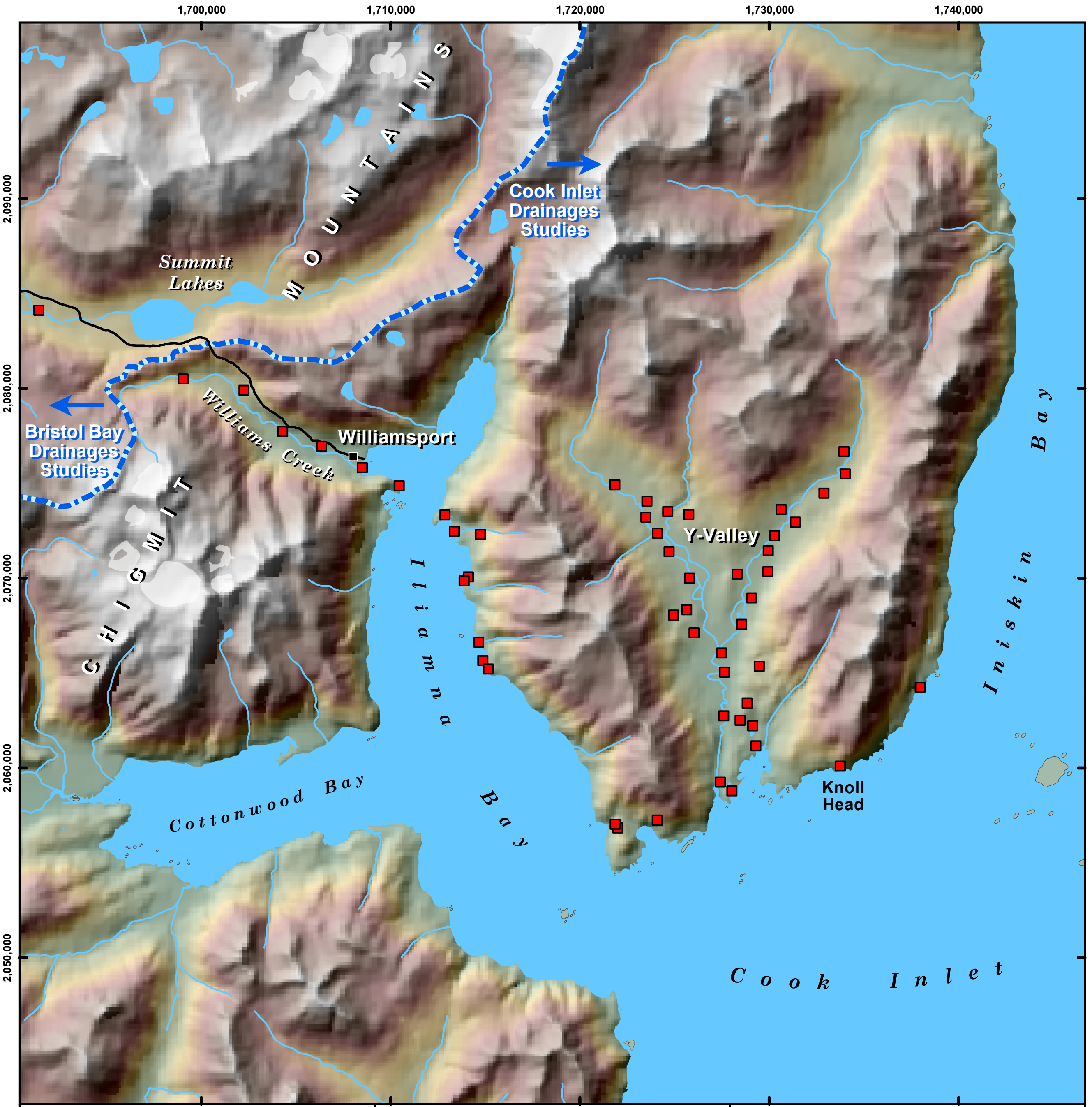
TABLE 41.5-8
Number, Percent of Total Observations, and Average Occurrence of Shorebird Species Observed during Point-count Surveys, Cook Inlet Drainages Study Area, 2005

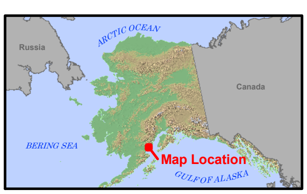
Shorebird Species	No.	%	Avg. Occurrence[a] (*n*=51)
Black Oystercatcher	7	100.0	0.137

Notes:

a. Average occurrence = number of bird detections divided by *n* (number of point-counts conducted).

FIGURES





Miles: 0 0.5 1 1.5 2 2.5

Kilometers: 0 0.5 1 1.5 2 2.5 3 3.5

Scale 1:100,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

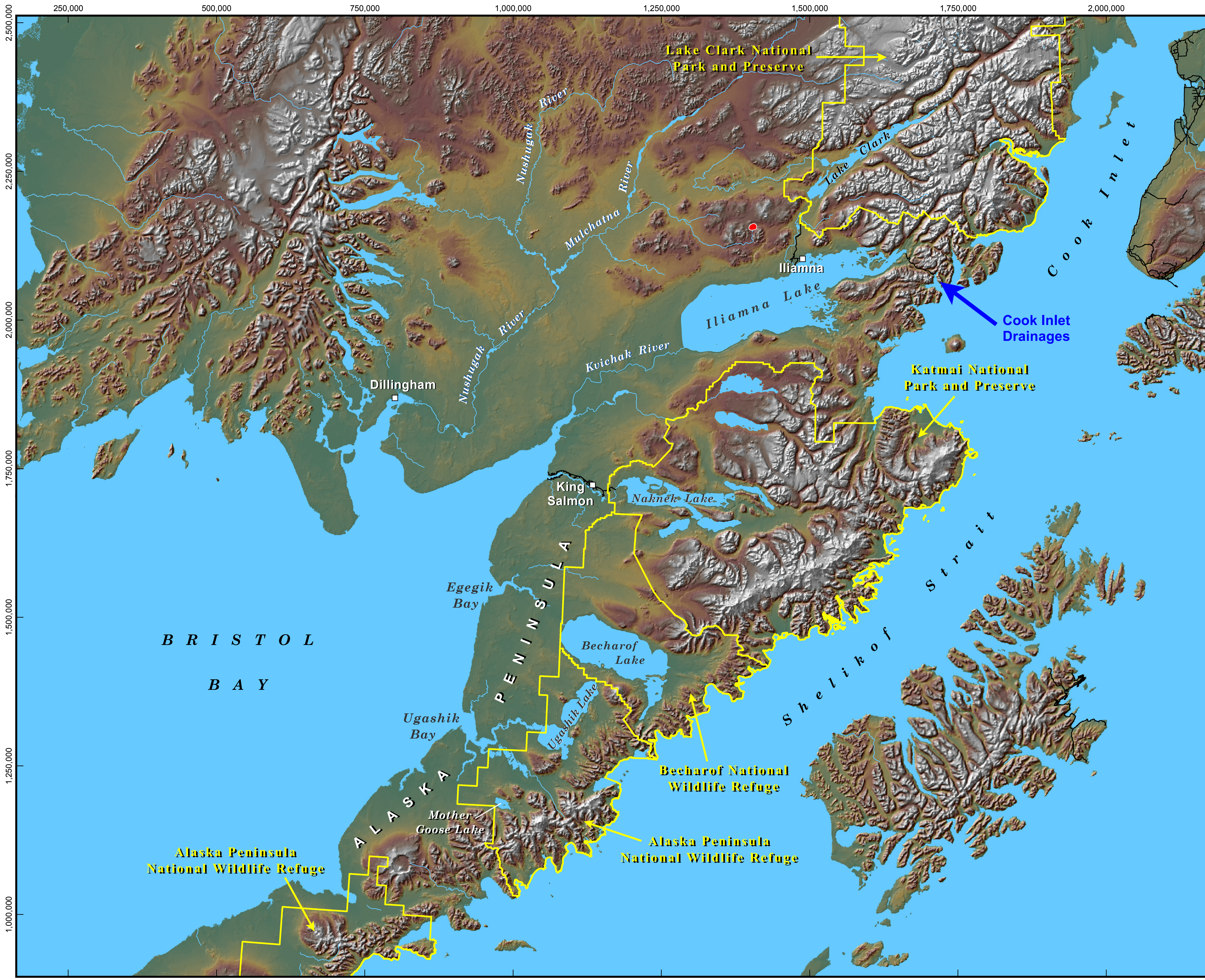
Legend

- Point-count Location
- Existing Road

THE pebble PARTNERSHIP

Figure 41.5-1
Landbird/Shorebird Point-count Locations, Cook Inlet Drainages, 2005

File: 41-5-1_BrBird_CookInl_PLP_EBD_v01.pdf	Date: Oct. 6, 2010
Version: 1	Author: ABR-AZC

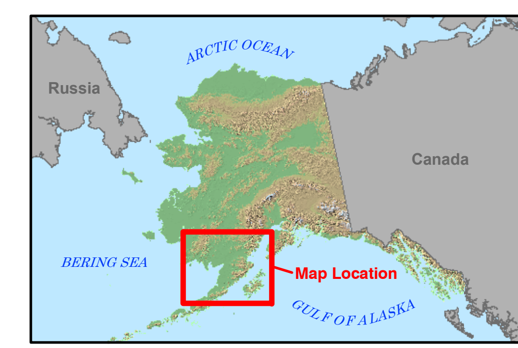


THE pebble PARTNERSHIP

Figure 41.5-2
Region Surrounding the Cook Inlet Drainages Study Area in which Previous Studies of Landbirds and Shorebirds were Conducted

Legend

- General Deposit Location
- Existing Road
- Town or Village



Miles: 0 10 20 30 40 50 60

Kilometers: 0 20 40 60 80 100

Scale 1:2,000,000

N

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 41-5-2_BrBird_Previous_PLP_EBD_v01.mxd	Date: June 17, 2010
Version: 1	Author: ABR-AZC

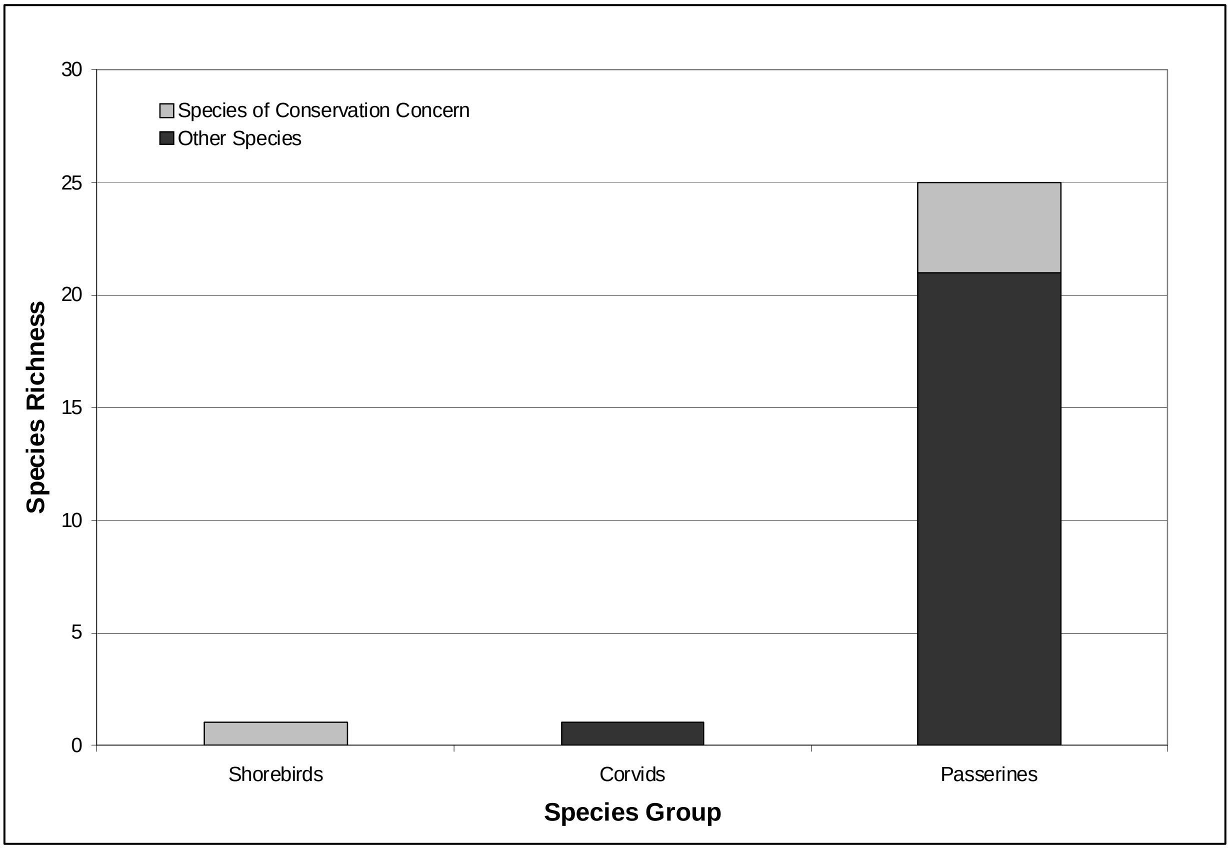


FIGURE 41.5-3
Numbers of Landbird and Shorebird Species (Species Richness), by Species-group, Recorded during Point-count Surveys, Cook Inlet Drainages Study Area, 2005

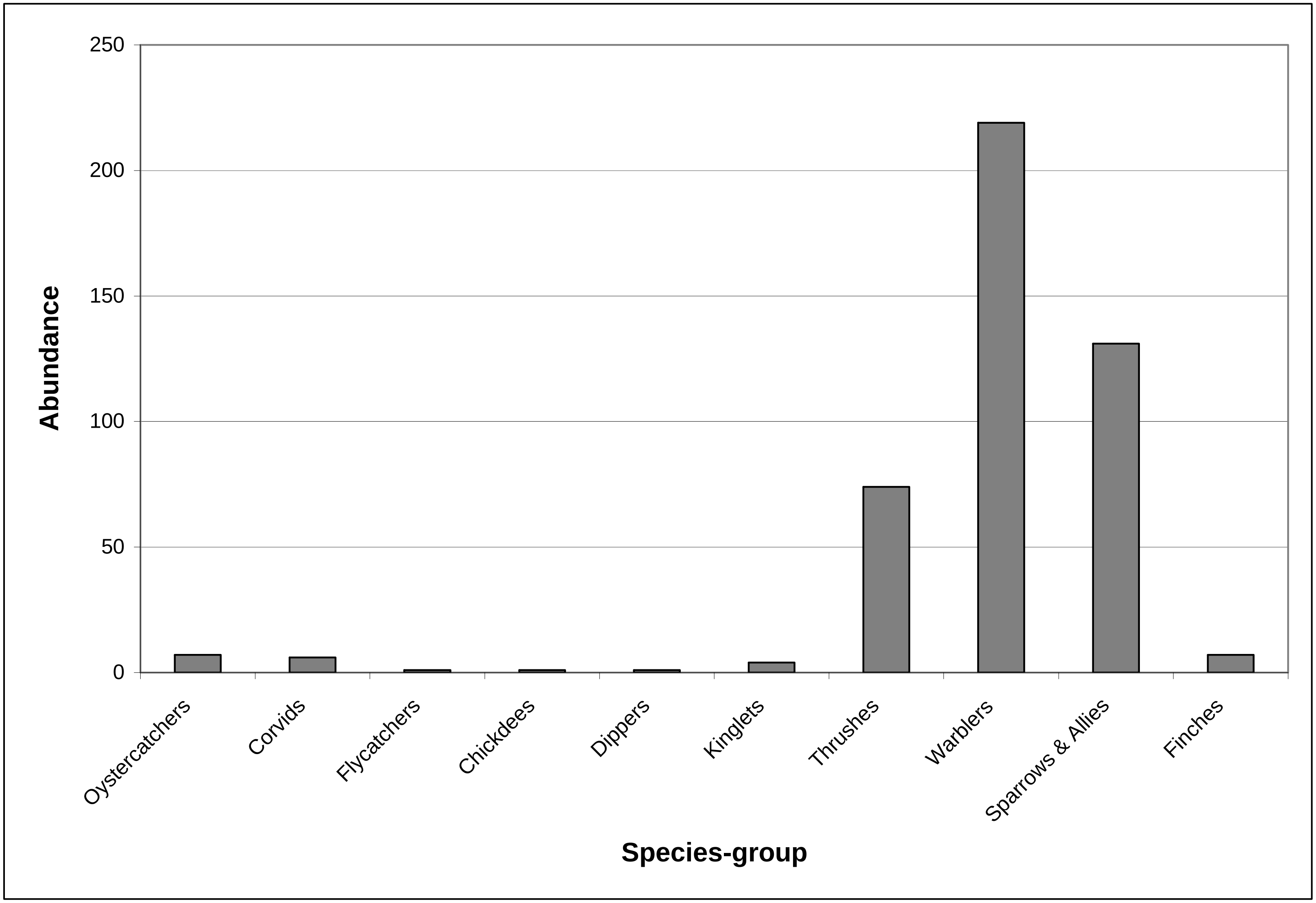


FIGURE 41.5-4
Abundance of Landbirds and Shorebirds, by Species-group, Observed during Point-count Surveys in the Cook Inlet Drainages Study Area, 2005.

APPENDICES

APPENDIX 41.5A

Numbers of Landbirds and Shorebirds Observed Incidentally during Point-count Surveys and In Transit between Point-count Locations Cook Inlet Drainages Study Area, 2005

Numbers of Landbirds and Shorebirds Observed Incidentally during Point-count Surveys and In Transit between Point-count Locations, Cook Inlet Drainages Study Area, 2005

Avian Species	No. Incidental[a]	No. In Transit[b]
LANDBIRDS		
Hermit Thrush	**3**	**0**
Fox Sparrow	**3**	**0**
Northern Waterthrush	**2**	**0**
Olive-sided Flycatcher	**1**	**0**
Black-billed Magpie	**1**	**2**
Common Raven	**1**	**0**
Yellow Warbler	**1**	**0**
Lincoln's Sparrow	**1**	**0**
SHOREBIRDS		
Short-billed Dowitcher	**1**	**0**

Notes:

a. Incidental observations were recorded at point-count locations but not during the count period.

b. In-transit observations recorded while moving on foot between point-count locations are observations of less commonly recorded species, in this case showing defensive behavior indicative of the presence of a nest.